UN-REDD PROGRAMME

Food and Agriculture Organization of the United Nations

UNDP

UN environment

MINING SECTOR ENGAGEMENT AND INTEGRATED LANDSCAPE MANAGEMENT

OPERATIONALIZING ZAMBIA'S NATIONAL REDD+ STRATEGY

UN-REDD Programme, 2017. Mining Sector Engagement and Integrated Landscape Management: Operationalizing Zambia's National REDD+ Strategy

Acknowledgements

This report was authored by Gabrielle Kissinger and Benjamin Warr. The authors would like to thank Thais Narciso and the UN-REDD Programme for overall guidance and support of this project. Input from the following interviewees was greatly appreciated: Ignatius Makumba, Deuteronomy Kasaro, Davies Kashole, Maureen Mwale, Moses Kaumba, Mindenda Pande, Njekwa Namushi, Mr. Nkwapu, Mabuchi Chilembo, Mr Joseph Ngwira, Chief Mumena XI, Chief Musele, Talent Ng'andwe, Garth Lapperman, Christopher Mukala, Arnold Malambo, Winnie Kakunta, Simon Mulenga Mwansa, Godfrey Phillip Msiska, Ian Milimo.

Table of Contents

List of Tables and Figures

1. INTRODUCTION AND CONTEXT

Forests cover around 45 million hectares in Zambia, or over 60% of the total land area. The Government of Zambia is aware of the prevailing high deforestation rate in the country, which is estimated between 250,000 – 300,000 hectares per year, and one of the top 10 countries with the highest deforestation rates in the world. The main direct drivers of forest degradation is charcoal production and illegal timber extraction, while drivers of deforestation are primarily agricultural and human-settlement expansion (Turpie et al, 2015). Mining activities play a key role in driving these activities, though there are regional and historical differences in forest transition patterns. The Government of Zambia decided in 2009 to participate in REDD+ as an opportunity to directly address the drivers of deforestation and forest degradation (Zambia, 2015).

North-Western Province's forests are nationally significant, as they contain the most intact forest cover and also the highest concentrations of carbon storage (Figure 1). Forest carbon storage in North-Western Province is generally more than 90 tonnes per ha, and in some areas, average carbon storage ranges up to 124.7 tonnes per ha (Turpie et al, 2015).

Development patterns in the Copperbelt and now in North-Western indicate significant rural influx once mines are established, largely due to rural poverty and the hope of financial gain by settlers. The result is the forest areas surrounding new settlements become a source of wood supplies; charcoal for brick making, cooking and selling for cash illegally; and agricultural land. A 2014 report by the Office of the Auditor General points to several institutional failures as contributing to the problems, including, a) inadequate measures put in place by government to ensure that environmental degradation caused by mining activities are effectively and efficiently managed; b) weak regulatory framework such as lack of revised EIA regulations, absence of water and air pollution control regulations, and lack of legislation for all producer responsibilities for companies generating waste; and c) failure by mining companies to contribute to the Environmental Protection Fund as required by law (OAG, 2014).
This link between poverty, rural influx to mining areas, and the role the mining operations play in drawing such influx, yet needing to manage it, in order to mitigate various risks (security, environmental and social issues) is at the heart of challenge. Vinya et al (2011) note that although the Zambian government has consistently expressed a wish to take development to rural areas, steering such development in a sustainable way has been an elusive intention, and low domestic earnings, coupled with high demand for fuelwood, have combined to exert strong pressure on forest resources in rural Zambia.

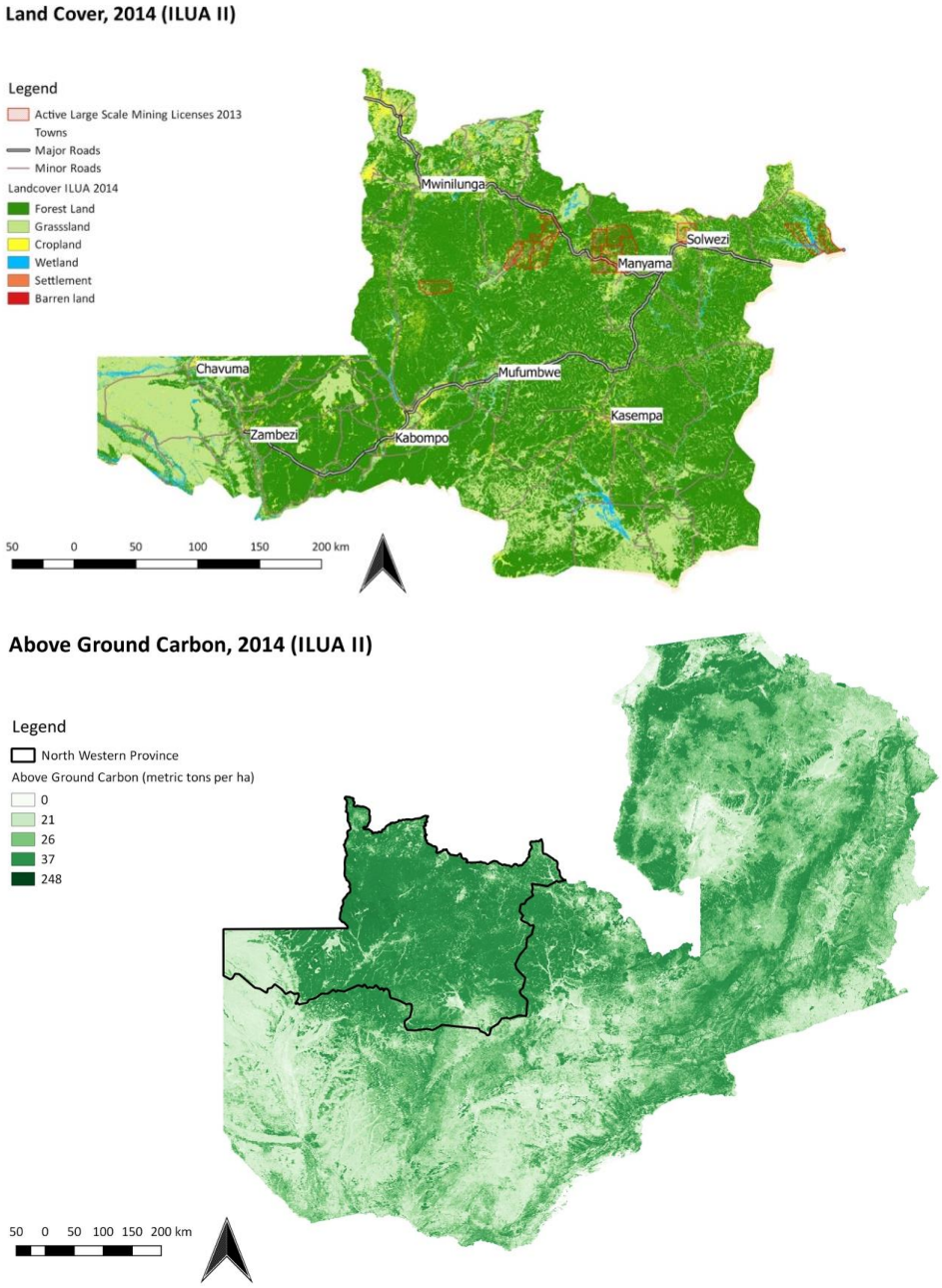


Figure 1. North Western Province Landcover 2014 (top), National above ground carbon 2014 (bottom): Source ILUA II

Above Ground Carbon (2014), Source ILUA II

A significant reduction in the area under PFAs has taken place by Government decree with more than 280,000 ha of forest reserve being degazetted or excised over ten years In North-Western Province. It is estimated that at least 350,000 ha of PFAs are undergoing conversion, a

process driven mostly by mining, and this conversion is likely to increase as new mines open up (Zambia, 2015).

This assessment is led by UN Environment and the UN-REDD Programme, in support of Zambia's intention to operationalize Zambia's National REDD+ Strategy. It is intended to assess the rationale and motivations for mining sector investment in REDD+ compatible activities, and to design and propose strategies for implementation. These strategies fall into two areas:

1. Areas of convergence in shared risks and opportunities for shared action between mining companies, communities, government and stakeholders, that builds upon a strong rationale for mining sector engagement (e.g. it must have a business rationale and fit within mining company operations).
2. Policies, measures and actions government can pursue to operationalize the mining sector component of the National REDD+ Strategy. It will be beneficial if these measures reinforce mining sector investment in key outcomes identified.

The assessment builds upon the following assumptions:

1. The REDD+ National Strategy and subsequent actions and measures can only be effectively designed if they correctly anticipate the broader evolution of sectors that influence deforestation, including the mining sector, and related
2. To be successful, REDD+ policies, actions and measures need to reflect the economic and financial drivers along with the risks and opportunities faced by all relevant sectors, including the mining sector.
3. The investment options must be based assessment of the economic and financial implications of a transition to reduced deforestation production for private sector companies, taking into account their objectives, and their competitive and legislative environment.

This document is a summary of key findings, and readers are encouraged to consult the longer version of this report, for further background, analysis and detail. This analysis is intended to also support and/or leverage two other activities supported by UNDP and The Nature Conservancy (TNC): a) Strengthening Zambia's extractives legislation, policy and financing mechanisms for REDD implementation in line with the African Mining Vision (AMV) (led by UNDP); and b) Geospatial Analysis to support decision-making on no-go areas and future mining development (led by TNC). The output of these assessments are to be consolidated into Zambia's REDD+ Investment Plan, which is being designed with support from the Forest Investment Program, under the leadership of the World Bank and the African Development Bank (AfDB) and the UN-REDD Programme.

This investigation relied on expert interviews in Lusaka and North-Western Province, interviews with stakeholders including the Forest Department; Kalumbila, Lumwana and Kansanshi mine staff; the Chamber of Mines; NGOs and CSOs, two local Chiefs, and others during September and October 2016. For a complete list of interviewees, please refer to Appendix A.

1.1 ZAMBIA'S CLIMATE AND FOREST GOALS

The Revised Sixth National Development Plan (RSDNP) and the Vision 2030 promote "A prosperous middle income country by 2030", and both support development of a low carbon and climate-resilient development pathway. The development of the Seventh National Development Plan (SeNDP, 2017-2021) is also underway which will take into account climate change issues. Zambia's climate change commitments were solidified in Zambia's Intended Nationally Determined Contribution (INDC) to the UNFCCC. The INDC notes that the majority of Zambia's greenhouse gas emissions come from land use, land-use change and forestry, and prioritizes three action areas to achieve Zambia's National Mitigation Goal, two of which are directly relevant to sustainable forest management and sustainable use of fuel wood derived from forests. The third adaptation goal (of three priority areas) seeks to protect water catchment areas, and the first activity is "Promote the protection of catchment forests in the Zambezi, Kafue and Luangwa watersheds." The Renewable Energy and Energy Efficiency component seeks to promote the switching from conventional and traditional energy sources to sustainable and renewable energy sources and practices (Zambia, 2015d).

The Forest Act of 2015 recognizes the need to 'devise and implement participatory forest management approaches for indigenous forests and plantations involving local communities, traditional institutions, non- governmental organisations and other stakeholders, based on equitable gender participation (Zambia, 2015 (c)). The Forest Act promotes the principle that forests and trees shall be managed as an asset for succeeding generations, and emphasizes the need to apply the precautionary principle to the development, management, utilisation and conservation of forest ecosystems, their biological diversity and habitats. The Act also allows for private forests and community forests to be designated, as well as joint forest management arrangements to be made. These provisions hold great potential to enable joint management by communities, mining companies and the Forestry Department within the Ministry of Lands, Natural Resources and Environmental Protection to find creative solutions to forest management challenges. One of the challenges identified by stakeholders is the lack of capacity in North-Western Province to effectively manage the extensive forest resources.

The Urban and Regional Planning Act (Act No. 3 of 2015) is intended to define the management of state land and customary land. Further definition of what areas should be managed for what purposes will occur at provincial and district levels.

Zambia's National REDD+ Strategy can help to implement Zambia's Forest Act and INDC commitments, and is intended to focus on tackling different drivers of deforestation both within the forestry sector, and with the engagement of other sectors, such as mining and land use (agriculture and energy are other priorities). The strategy will be implemented through a landscape approach at watershed level and through policy reforms at national level (Zambia, 2015).

2. ECONOMIC INCENTIVES AND DISINCENTIVES IN THE MINING INDUSTRY IN ZAMBIA

North-Western Province is the "New Copperbelt" and production has increased in the last five years. More than one billion tonnes of copper-cobalt ore has been extracted from the mines of the Copperbelt and it is projected that another two billion tonnes could be economically exploited in Zambia (Zambia, 2015b). Nickel and platinum group elements are also found in the region, along with gold. Farther downstream in the Zambezi watershed, oil and gas predominates, along with gemstones. Uranium is also prevalent, raising concerns over radioactivity risks from extraction in the region.

The market prices for key commodities mined in North-Western has declined substantially. Copper trading ranged from US$2.90 per pound to US$2.08 during 2015. Nickel fared worse in 2015, with a market swing from US$7.11 per pound to US$3.69. Prices in 2016 remain volatile, and share prices of companies in the industry have suffered (First Quantum, 2015a). Copper mined in North-Western Province requires large quantities of rock to be excavated in order to access significant amounts of copper. The need for such excavation requires a large amount of machinery, and overhead costs reflect the need to maintain machinery.

Exploration licenses are held by Rio Tinto and Anglo American MMG (China). Active mining licenses are held by First Quantum Minerals Ltd for Kansanshi copper/gold mine and Kalumbila copper mine, and Barrick Gold Corporation for the Lumwana mine. Independent South African companies are investigating the northern Zambezi.

The Zambia Chamber of Mines notes that **Zambia's competitive disadvantage globally largely rests on high labour and extraction costs**. Indonesia has costs of US$ 2000-2500 per tonne of copper, while costs in Zambia is US$ 4,400-4,600 per tone (due to cost of power and labour costs). The production tonnage per employee is lower in Zambia. Further, mines must deeply excavate, in order to reach the copper, which requires significant amounts of energy to pump out water (Chamber of Mines, personal conversation).

Hydropower, primarily from the Kariba and Kafue Dams is the main source of energy mines depend on. Mines have created their own dams to supply power, but largely rely on the ZESCO grid for power. North-Western mines account for roughly 10% of the country's energy—Kanshansi uses 7.2%, Lumwana uses 2.54% and First Quantum (likely Kalumbila) uses 0.2% of national grid energy (Zesco website).

The **operational context for mining companies in Zambia is constrained by a range of factors, including regulatory changes in 2015 (see below), which impacted investor confidence, and power supply and cost issues**. Rainfall patterns have been erratic in recent years, impacting hydropower production. Hydropower accounts for over 90% of total electricity generation in Zambia. In February 2016, the government increased power tariffs for mining companies in a bid to lure companies to invest in power generation. The rate hike of 26% will increase power

prices for companies including Barrick Gold and Glencore to USD$ 0.14 per kilowatt-hour (kWh), up from USD$ 0.082/kWh previously (BMI Research, 2016).

Amendments to the Mines and Minerals Development Act passed in 2016 changed Zambia's mining tax regime in order to reduce the royalty rate from 9% for copper extracted from both underground and open cast mining operations to a sliding scale of between 4% to 6%, based on the copper London Metal Exchange price and the repeal of the variable profits tax. The amendment also reduced the rate of mineral royalty for other base metals to 5% for both underground and open cast mining operations. The rate for gemstones and precious metals was set at 6% for both types mining operations (Government of Zambia, 2016). However, erratic changes to both the royalty and corporate tax rate in 2015 shook the industry, though indications are this has stabilized. On January 1, 2015, the royalty rate increased from 6% to 20%, which resulted in incremental royalty costs of $97 million in the first half of 2015 for First Quantum Minerals. Effective the same date, the corporate tax rate in Zambia was reduced to 0% from 30%. Thus, in the case of First Quantum, no taxes were owing in the first half of 2015. The corporate tax of 30% was reintroduced alongside the 2016 amendment to the Mines and Minerals Development Act, which decreased the royalty rate for First Quantum from 20% to 9% (First Quantum, 2015a).

Zambia's economy is largely service-oriented with the tertiary sector at 53.7% of GDP; mining at 12.9%; agriculture, forestry and fisheries at 9.9%; and manufacturing at 7.9% (National REDD+ Strategy cites Central Statistics Office, 2014 and Turpie et al., 2014). However, significant portions of the agriculture, fishery and forest sectors are informal and therefore not accounted for, and the water sector (hydrological services) is also not accounted for.

The active mining operations in the region are located in former protected forests or adjacent to them. As Figure 2 depicts, active large-scale mining licenses overlay protected forests (in all cases degazetted to allow for the mine) at Kanshansi, Lumwana, and Kalumbila.

As the major mining activity moves away from the highly urbanized Copperbelt Province to the sparsely populated North-Western and other provinces, **traditional Chiefs holding customary title to 94% of Zambia's land have a more prominent role in mining**. Sixty three percent of Zambia's forest area is on customary lands (Turpie et al, 2015). Thus, the establishment of mines likely requires approval by local traditional leaders. Such approval has focused most heavily on the resettlement of people residing in areas with customary rights, in order to make way for mines. The development rights of a large-scale mining license holder are guaranteed by Section 23 of the Mines and Minerals Act of 2008. However, it is largely recognized that companies seeking to operate with a social license must consult and reach agreements with local chiefs (KPMG, 2013).

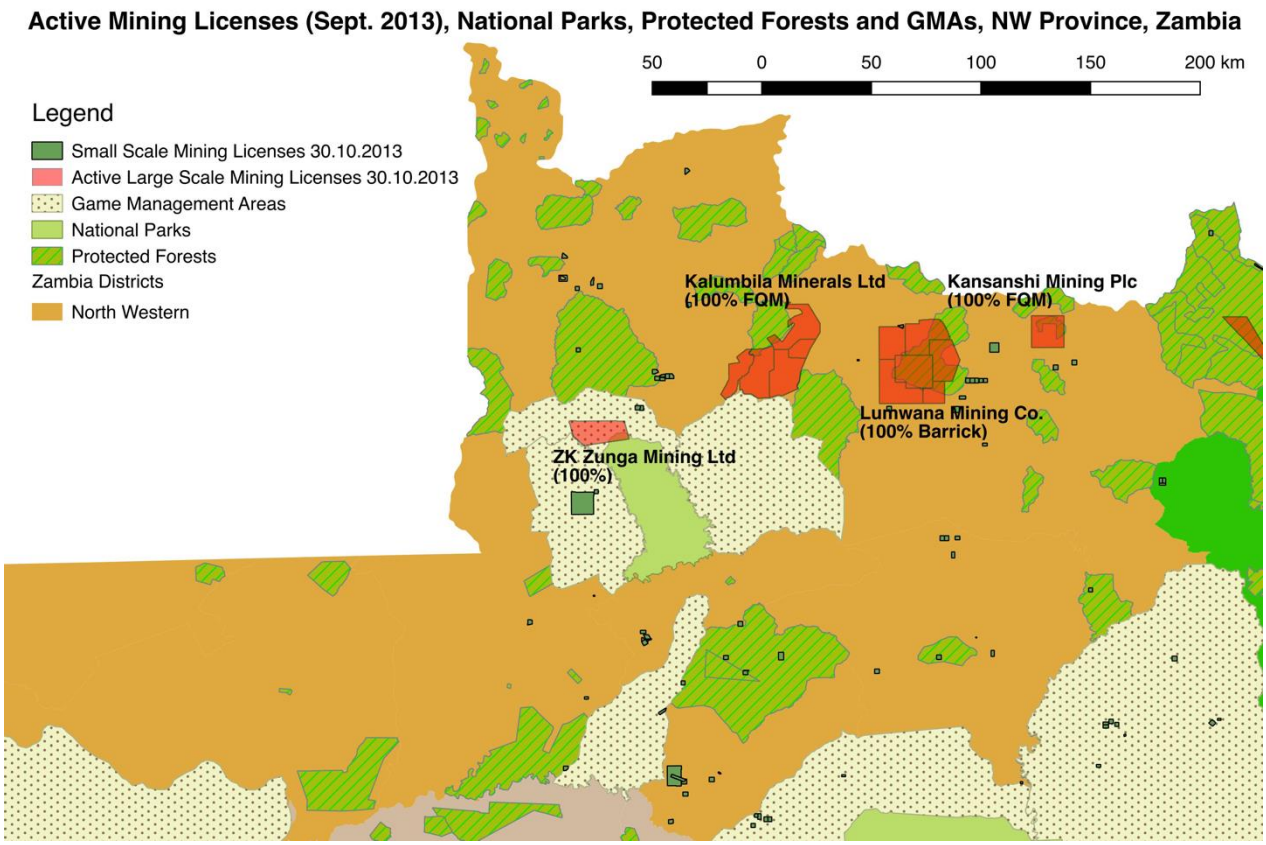


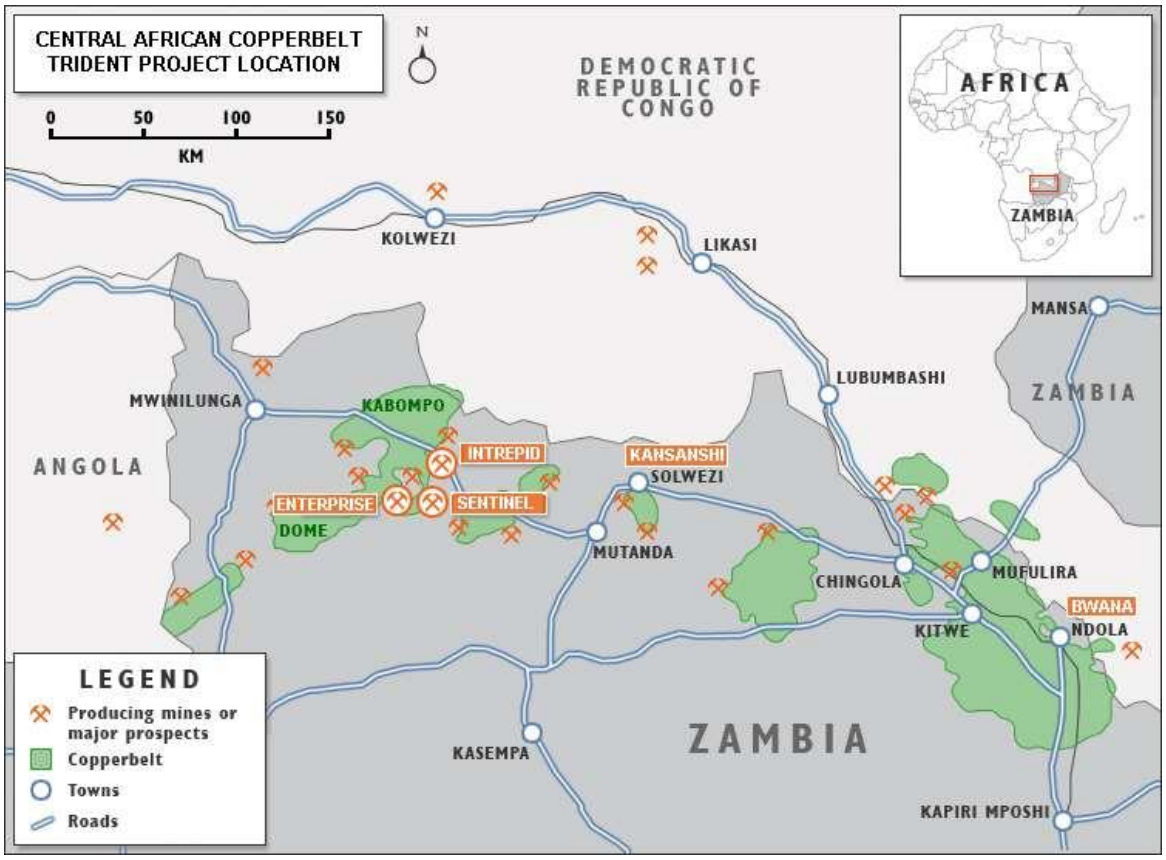
Figure 2. Active mining licenses in North Western Province (Sept 2013): Source: Dr Benjamin Warr

The heavy imbalance in power relations between Chiefs and mining companies from exploration stages through to the approval to mines and conversion of land is a serious concern for all parties. The negative social ramifications are largely unexplored. 'Soft' investments made to support community advocacy, empowerment, legal advice and strategic governance are likely necessary to ensure the long-term integrity of material projects and the long-term economic and social well-being of people. Investment in the establishment of Community Forest Projects (CFPs) and Community Based Natural Resource Management (CBNRM) can also help fill this governance gap, while also supporting REDD+ objectives.

3. OPERATIONAL AND STRATEGIC INSIGHTS ON KEY COMPANIES IN NORTH WESTERN PROVINCE

3.1 FIRST QUANTUM OPERATIONS

First Quantum Minerals (FQM) got a foothold in North-Western Province with the opening of Kansanshi mine in 2005. First Quantum Limited acquired the Sentinel copper deposit project in February 2010. The Trident project is comprised of five prospecting licenses totaling 230,000 hectares (2,300 sq. km), which FQM received in April 2011 (refer to Figure X below). The licenses give FQM the exclusive rights to carry out mining operations on the full area of Trident for a period of 25 years (KPMG, 2013).



Source: First Quantum Minerals (2015)

Figure 3: First Quantum Trident Project locations

3.1.1 KALUMBILA MINE

The Trident Sentinel copper project scope is US$2.1billion, with Kalumbila mine as the first development. Commercial production has not yet been announced. Intreprid is still in the exploratory stages. Copper concentrate is being produced at Sentinel, with smelting occurring near Solwezi. The Trident Enterprise nickel project scope is estimated to be 40.1Mt, at 1.07% nickel, and an operational potential of 38,000 – 60,000 tonnes of nickel produced per annum.

The nickel deposit is not currently being mined, and a decision to begin production will depend on nickel prices and the concentrate export levy. The quarry at Intrepid is used for aggregate now, and there are three pit crushers (First Quantum Minerals, 2015 and First Quantum website).

The mining surface rights area extends 385 sq. km, or 38,500 hectares. The footprint of the mine itself is about 100 sq. km or 10,000 hectares. Two dams were established on rivers that cut through mine site. Mining waste goes into mine waste dumps (Trident Foundation, personal communications). The total measured & indicated resource at Sentinel is 1,033Mt, at 0.53% copper. The strip ratio indicates one tonne of ore will require 2.2 tonnes of waste rock. It is estimated that operations will see a target throughput of up to 55 million tonnes per year to achieve economies of scale, with 280,000 – 300,000 tonnes of copper production per annum. The 265,000 tonnes of freight is expected annually, accommodated by 14,500 truckloads. Once resource drilling is complete, the production target may be increased further. The capital expenditure (capex) is estimated at US$1.725 million. The estimated marginal cut-off grade reflects a copper price of $3.00/lb Cu and 6% Zambian Government royalty. The project relies on 600km of ZESCO 330kV transmission lines (First Quantum Minerals, website).

FQM negotiated an agreement with a local chief, Chief Musele, for 51,800 hectares (518 sq. km) of customary lands in 2011 which covers a significant portion of three of FQM's five license areas. The compensation for the Chief to grant a non-rescindable and exclusive grant of land was vastly undervalued, compared to the commercial and market value of the mining access, minus the capital expenditure required to develop the mine. The agreement also set aside a comparable amount of funds to establish the Trident Foundation, which is FQMs CSR development foundation (Senior Chief Musele and Kalumbila Minerals Limited, 2011). Roughly half of the funds that were part of the mining company's acquisition of the right to land are now managed by the Trident Foundation and expressed in FQM's marketing materials as being CSR activities, when in fact they were part of the payment for the right to customary land. FQM provided resettlement houses built to local standards for over 600 of Chief Musele's community. Conservation farming practices have been shared with Chief Musele's community, but they were predominantly hunters, so the adjustment has left the community at a disadvantage. Further, they also now lack access to the forest area, as they are situated on the other side of the mine fence. The area adjacent to the land Chief Musele was settled into now also contains many other settlers who have moved there from all over Zambia in search of economic gain, and the level of influx is acknowledged to be detrimental to both Chief Musele's interests and the Kalumbila mine.

Importantly, ZEMA's approval decision made clear that the terms of the mine license and approval of FQM's development plans for Kalumbila must include two key environmental and social actions: 1) Kalumbila shall work with and support the Forest Department to develop forest management, covering plans for the forest areas around the mine areas and to enhance and mitigate the social and environmental and economic pressures which will arise due to the development of the mine; 2) Kalumbila shall avoid unnecessary clearing of vegetation and avoid soil erosion (License condition 3.1.6 for Enterprise and 3.1.8 for Sentinel).

FQM had a portion of National Forest degazetted in order to site the mine operations, but was not able to degazette the National Forest surrounding their mine license, on which they own exploration licenses (reserves are not proven there). FQM has a Memorandum of Understanding (MoU) with the Forest Department which will describes shared intentions to develop a suite of practices/investments to better manage two National Forest blocks and the Masele Mateo Game Management Area:

1) Lwalaba Forest Reserve No 112 – total area 1019 km^2 – Encroachment is a problem here, as 97 families have already encroached, and more are expected.
2) Bushingwe Forest Reserve No. 103 – total area 329.5 km^2
3) Masele Mateo Game Management Area (GMA) – FQM has signed an MOU with Zambia Wildlife Agency to provide material support, capacity building, and then game restocking of mammals last seen in the area 30 years ago. FQM has bred 10 species in Kalumbila, so once population numbers are high enough, the GMA and Protected Forests could be restocked. Success in this regard requires that they deal initially with the influx and encroachment problems they face. The development of a sustainable bushmeat and eco-tourism operation could present a good fit with the traditional communities of the region (Kaonde Tribe), who are hunters not farmers. The infrastructure provided by the mine (including the airport which may in future be able to accept flights from RSA) could enable service and travel development.

FQM started a woodlot and plantation programme in 2013, but did not achieve success. Livelihood support programmes include income generating opportunities such as ecotourism, mushroom harvesting, and beekeeping. The Agriculture Livelihood Programme includes conservation farming, maize and cassava growing, and green charcoal making. The target is the two resettled areas, but interest has spread to surrounding communities. Kalumbila has negotiated offtake agreements with local producers of cassava, so that 800 farmers can produce cassava to serve the mine's utilization of starch derived from cassava. A sawmill and furniture factory were established, which provided 1,500 school desks for area schools from timber cleared due to mine establishment.

FQM/Kalumbila and Trident Foundation staff noted in personal communications that the primary driver for their engagement in the above activities is to fulfill their EIA requirement; the ethics of the company, given that these were decisions made at the Board level; the international requirements made by lenders and investors; and due to their ability to undertake such activities as a large multi-national company.

3.1.2 KANSANSHI MINE

The Kansanshi mine is the largest copper mine in Africa, is owned and operated by Kansanshi Mining PLC which is 80% owned by a First Quantum subsidiary. The remaining 20% is owned by a subsidiary of ZCCM. The mine is located approximately 10 kilometres north of the town of Solwezi (refer to Figure 3).

The mine has undergone several expansions since it began operating in 2005. Kansanshi is now capable of producing 340,000 tonnes of copper and more than 120,000 ounces of gold per year. A multi-stage expansion project aims to increase copper output capacity to approximately 400,000 tonnes by 2016. In 2015, a new copper smelter was put on-line at the Kansanshi. In 2015, sales revenues decreased by 21% from 2014 due to lower copper and gold prices, and sales volumes that were 7% lower. Gross profit in 2015 decreased by 71% compared to 2014, reflecting the decrease in sales revenues and increased royalty charges and depreciation. (First Quantum Minerals, 2015a). Loadshedding has had a strong effect on operations and on energy needs. Kansanshi decided not to get thermal power electricity from their smelter, and rather invested US$100 million into an alternative power line.

Influx issues have been most severe at Kansanshi, as all the area around the mine towards Solwezi has been settled and cleared. The population of Solwezi is now estimated at around 400,000 to 450,000, but the region may see as many as 1 million. Much of the population is transient, and only recently settled there. There have been cases of people climbing over fences to steal copper, so security is taken seriously.

Disturbed protected forest areas are hoped to be degazetted and tree planting has occurred around tailings piles. Kansanshi is working on creation of a mechanism with the Forest Department to compensate for lost areas, which so far has included commitment to help replant trees and to provide assistance for logistics and fuel to help the Forest Department to monitor local charcoal use. Ten percent of the mine surface rights were set aside as a conservancy, where game restocking has since occurred.

Kanshanshi staff note that deforestation was not as noticeable a problem until two years ago, once electricity supply disruptions started occurring. Deforestation is now happening at a massive scale, and observations are that it is serving a national demand for charcoal. Both indigenous people and migrants have found a business opportunity, and are utilizing it.
The Illegal timber industry in the region is also big, and staff that were interviewed noted visible production of large redwood (rosewood) blocks being transported on trucks with DRC and Tanzania license plates, indicating the direction of transport. Though raw law export is not allowed in Zambia, trade is allowed within the country.

The CSR Department has been involved with the local community on a package of interventions including conservation farming and green charcoal. Green charcoal has been a priority area, with maize cobs converted into charcoal. Up to 3,000 people have been trained on green charcoal production, but the challenge is to secure maize cops and obtain the raw materials. Conservation farming has been occurring for 5-6 years, with 22,000 farmers trained. Another 400 farmers are practicing beekeeping.

Kansanshi's CSR budget is flexible, and completely dependent on the copper price, and identified needs. CSR staff discuss with community leaders what the needs are, and bring those priorities to the attention of the Board. Kansanshi views its social license to operate as being dependent on meeting these needs (CSR staff, personal communication).

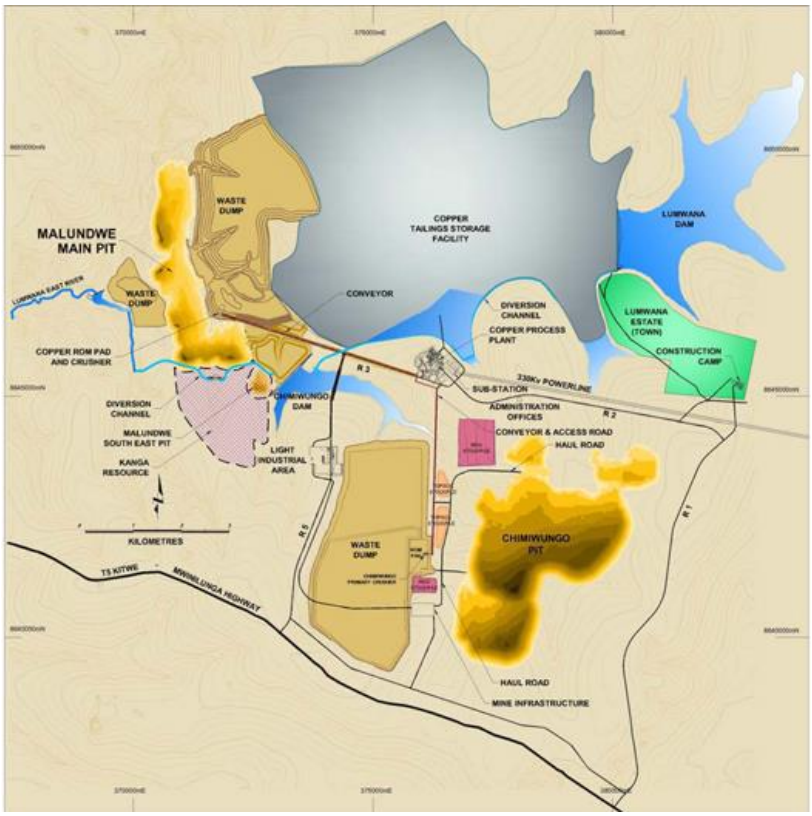
3.2 BARRICK OPERATIONS

Barrick's Lumwana copper mine is located between Solwezi and FQMs Kalumbila mine. Proven reserves are 3.1 billion pounds (246.7 million tonnes, grading 0.56%). Lumwana ore, which is predominantly sulfide, is treated through a conventional sulfide flotation plant, producing copper concentrate for smelting. Production is anticipated to be 270-290 million pounds at costs of $1.80-$2.10 per pound in 2016. Lumwana produced 287 million pounds of copper in 2015, at a cost of sales of $440 million, and average costs of $2.42 per pound. Energy used at Lumwana was 3,014,592 GJ in 2015.

The Lumwana Large Scale Mining License ("LML-49") covers an area of 1,265 km^2 and includes two major copper deposits, Malundwe and Chimiwungo, together with numerous exploration prospects. LML-49 covers copper, cobalt, gold, silver, uranium and any additional minerals that may be commercially extracted or that are required for Lumwana's development. LML-49 was granted on January 6, 2004 and was issued for 25 years, renewable for a further 25 years. Lumwana also holds the long-term land title to 35,000 hectares of township and mine operating areas in LML-49. This land title, which is granted by the President and is the highest form of land tenure in Zambia, enables Lumwana to manage and administer the Lumwana surface rights (Barrick Gold Corporation, 2012).

Copper concentrate from the Lumwana mine is sold to Zambian smelters, and given the availability of purchasers, Barrick is not dependent upon the sale of copper to any one customer. However, Barrick notes one of the critical indicators of financial success as a copper producer is the state of economic growth and political conditions in China, which has become the largest consumer of refined copper in the world, and other major developing economies (Barrick, 2016a).

Barrick publicly discloses its community investments, which have ranged from US$285,000 in 2012 to as much as US$1.7 million in 2013. Land use and compensation payments vary year to year, with none made in 2014, while 2015 saw a more substantial US$1.6 million (Barrick, 2015).



Source: Barrick, 2012.

Figure 4: Barrick Lumwana mine, Zambia

Barrick implements a global human rights compliance program, which is aligned with the UN Guiding Principles on Business and Human Rights. Since 2013, all higher and medium risk operations and projects have been assessed by this compliance program. Barrick is listed in the Dow Jones Sustainability World Index, and received a Gold Class Sustainability Award. Barrick participates in voluntary sustainability initiatives, such as the Extractive Industries Transparency Initiative and the Carbon and Water Disclosure Projects (Barrick, 2016a).

Barrick's Lumwana Corporate Social Responsibility programme is staffed with 11 people. The annual operating expenditure for overhead is US$400,000 per year and expenditure on programmes is US$1 million. The local communities adjacent to the mine site that are of focus include Mukumbi, Mumena & Matebo chiefdoms and Manyama. Barrick's social risk categorization system identifies the surrounding areas as a Level 2 medium risk site. The Manyama settlement is a high risk zone.

In 2016 Barrick identified five top 5 priorities for CSR and community engagement, and the top one is influx management, which includes security, water and sanitation, but also includes impacts on forests, due to charcoal harvesting and burning due to increased influx. Barrick CSR staff identify there is scope for partnerships on charcoal, given the scale of the challenge, and how integral it is to the influx issue. Other CSR top five priorities include community mine trespass, Presidential and general elections, local content complaints, and community relations audits (Barrick, 2016b). Barrick has established a Land Use Planning and Development Committee, which meets on a quarterly basis, with senior management in attendance. The Manyama Integrated Development Plan is in process. Efforts on water and sanitation have included introducing fee payments for water.

4. INVESTMENT OPTIONS

The rationale for investment in activities that helps protect the Zambezi watershed and the forests of North-Western Province can be broadly defined as investments that have commercial benefit, in addition to the social and environmental benefits. Such activities or projects do not include expenditure on *a priori* obligations stipulated by legislation, for example compliance with environmental or social regulations, and additional investment requirements imposed during negotiations with Government to secure license to operate. Therefore, in the context of this report, we limit ourselves to **examination of activities which extend beyond the core activities of mining companies in the region and should be part of sustainable mining**. These investments beyond the mine site and direct employees, which can be referred to as '**beyond compliance'** investments.

While much harder to quantify than direct earnt revenues, beyond compliance investments can bring significant benefits in the form of **reduced risk** and greater real options[1] value accruing to the corporation. Discussions with the Barrick Lumwana, First Quantum Kalumbila and Kansanshi mines indicates there is a need to think beyond the scope the mines directly operate in, to bring communities and the region together to address regional risks. Mining companies also identify that the weak enforcement of current binding rules and regulations on forest exploitation for charcoal production and timber extraction is the main driver of weak governance in this space. There is interest on the part of companies and the government to pursue partnerships to address future risks. The following section elaborates on:

Identification of problems and solutions: Interviews conducted with key stakeholders in North Western Province and a preliminary workshop held in Lusaka, involving mining companies, traditional leaders, local government and representatives of civil society, helped identify the REDD+ compatible strategic interventions that could be prioritized by the mines.

Strategic response documentation: Priority interventions were then grouped under four strategic option topics: *energy, agriculture, forest biodiversity* and *governance*.

Preliminary ranking (gap analysis): The criteria for ranking of interventions included the perceived relative importance in reducing forest loss and degradation, the likelihood of realising those expected benefits (weighted across multiple benefits), an estimated cost range, expected time horizon to realise benefits and primary risks and benefits that may be realised.

[1] A real option is the right, but not the obligation to undertake certain business initiatives, such as deferring, abandoning, expanding, staging or contracting a capital investment project.

Table 1: Priority areas for intervention

Risks identified	How risks impact stakeholders	Possible solutions
Loss of land and access to forests	• Communities rely on land for their sustenance, traditional and customary lands are their largest asset • Mining companies see increased security risk from development adjacent to mines • Government resources for management of uses is limited	• Community Forest Projects (CFPs) and Community Based Natural Resource Management (CBNRM) • Establishment of 'no-go' areas for mining
Influx and illegal settlement	• Often results in illegal and unmanaged charcoal production, timber and wildlife resource extraction • Local traditional leaders are challenged to manage influx without the help of regional government (e.g. policing, enforcement) • Energy and waste systems are stressed • Resources lacking for policing unsustainable and illegal practices	• Improved planning for new uses, restrictions on expansion into forests • Access to modern energy: - Large-scale centralised energy production - Distributed energy production • Sustainable and alternative charcoal • Climate-smart agriculture
Land and water resource degradation	• Long-term loss of ecosystem services • North Western Province contains the last in-tact forests, which provide watershed protection for the entire Zambezi River system (national and international importance) • Puts pressure on mining companies to provide alternative service provision	• Community Forest Projects (CFPs) and Community Based Natural Resource Management (CBNRM) • Establishment of 'no-go' areas, identified for ecosystem function values
Illegal extraction of forest resources	• Illegal and unmanaged charcoal production, timber and wildlife resource extraction which government agencies can't manage	• Alternative means of revenue generation, including NTFPs, sustainable bushmeat, game reserves

	• Land and water resource degradation, which increases both public and private sector risks • Loss of government revenue from illegal extraction	• Regulated and sustainable charcoal supply chains • Improved enforcement of restrictions on timber harvesting (rosewood)
Governance/enforcement of laws	• Disparity in negotiation power between local communities and mining companies creates tension and impacts customary land rights • Mining companies more equipped and financed to provide governance functions in the Province than the Forest Department	• Increased focus and resources for local communities to define land management intentions and outcomes • Partnership opportunities between mining companies and government agencies

4.1 OPTION ANALYSIS

Each priority intervention topic (*energy, agriculture, forest biodiversity* and *governance*) are explored. First, the topics are defined, the strategic response areas are then further refined. Then each option is evaluated for its likelihood to address the identified risks or problems, the scale of the intervention necessary to have impact, the costs for investment and implementation, and time requirements. For all, there is a recognition that strategic interventions be defined at a regional to national in scale.

The next step involves detailing and ranking of strategic interventions, informing a gap analysis wherein we assess the disparity between actual and required capacities in each investment option to provide a ranking of priority interventions. The criteria for ranking of priorities includes the perceived relative importance in reducing forest loss and degradation, the likelihood of realising those expected benefits, an estimated cost range, expected time horizon to realise benefits and primary risks and dis-benefits that may be realised. The subsequent gap analysis seeks to determine the approximate costs, required steps and general feasibility for the mines to move away from business as usual and implement some of the options, in partnership with government and communities. Other criteria for evaluation of relevance included:

- Cost-neutrality of the intervention options
- Alignment with REDD+ strategic objectives and outcomes
- Potential to achieve outcomes
- Key enabling factors such as governance, improved livelihoods, community engagement, and partnership potential.

While this section identifies the above factors to evaluates operational and strategic viability of the options, this analysis did not assess the potential public and private costs of inaction, or avoided costs. Such estimation would be helpful in the future.

Intervention 1 - Energy

The dynamics of energy supply and use in Zambia across residential and commercial sectors is dichotomous. On the one hand, it involves centrally produced supplies generated by hydro-electric facilities in the south of the country and distributed nationwide. On the other, supply of fuelwood for rural dwellers is largely a subsistence based activity, while the production of charcoal for urban dwellers provides many rural households with a source of income. Relevant options for investment therefore include:

1. Large-scale centralised energy production – serving both industrial and domestic use;
2. Distributed energy production facilities – for specific mine facilities or ‘off-grid’ communities;

3. Sustainable and alternative charcoal – for domestic use.

1. Energy - Large-scale centralised energy production

Even with much of the country beyond the transmission network, demand for electricity exceeds supply. Load-shedding exerts significant pressures on all forms of industrial activity, including mining, which consumes approximately 58% of all supplies. In 2015, the total installed generation capacity increased to 2,411 MW, when a small hydroelectric plant was added by ZESCO (ERB, 2015). However, the electricity demand forecast for 2020 is close to 3,000 MW, indicating a supply deficit of some 600MW. Further, the available capacity is roughly 50% lower than the installed capacity, indicating a larger deficit (Chamber of Mines, 2017a).

The gap between electricity demand and supply is the result of slow investment in supply,[2] and tariffs are being revised upwards. Proposed tariffs on new power projects have been described as above international benchmarks (Chamber of Mines, 2017a). **Mining companies see a growing business case for investing in large-scale captive power production facilities**, as exemplified by the Copperbelt based mining company Konkola Copper Mines Plc ('KCM') recent decision to invest in a 300MW captive power plant. ZESCO will likely incrementally increase tariffs over the coming years, which will bring tariffs closer to or exceeding the costs of production, which will encourage investment. **Increased large-scale electricity capacity could also benefit local communities, increasing rural access to grid energy, and could decrease some demand for charcoal.**

1.1 Efficacy in addressing risks/problems:

If scaled to supply of both industrial use and growing urban populations in the region, some may speculate that such investments could reduce urban charcoal demand. One report suggests "that access to electricity has a negative and significant influence on charcoal consumption, and can potentially reduce household monthly charcoal consumption by 47%," (Tembo et al 2015). However, the 2015 Zambia Living Conditions Monitoring Survey indicates that 59.1% of urban households use charcoal (Zambia, 2015 (e)), which indicates that electrification does not easily replace charcoal use. Interviews in Lusaka found that electricity was mostly used for lighting, refrigeration and/or television. For cooking, however, electricity is used only sparingly, because the tariffs are considered unaffordable (SEI, 2013). The low cost of charcoal makes it the preferred cooking fuel for many urban households, and as long as there is low-cost charcoal on the market, demand will stay strong. While the need for electrification is clear, there are large technical, economic and cultural barriers to electrification reducing demand for charcoal, and alternative incomes for households dependent on charcoal production must be found. **Therefore, this option may not be as effective at replacing charcoal demand, but does help support community access to electricity.**

[2] Prior to the 360MW Kariba North Bank Extension completed in 2015, the last major power plant to be commissioned in Zambia was the Kariba North Bank, in 1977.

1.2 Scale of the intervention necessary to have impact:

Production would likely need to be developed in the region, serving regional and national transmission and distribution systems. The benefits to REDD+ of electrification in North Western Province alone are limited unless a national perspective to power production is taken. It would be necessary to install generating capacity to supply the major fuel wood deficit areas of the Copperbelt, Central and Lusaka Province to ensure significant reductions in charcoal demand and relieve large areas of forest from degradation due to charcoal production. Assuming a mean annual increment of 1.65 metric tons dry matter equivalent (mt DM eq), per annum per ha, then a total area of 34,516 ha of forest could be relieved from any form of charcoal production. This is a relatively small area of the Province, equivalent in size to a mid-sized ward like Manyinga.[3] Importantly, in the above calculation we have assumed off-take at the level of the mean annual increment, which is a sustainable off-take.

1.3 Costs for investment and implementation:

Capital costs for large-scale power production vary depending on the type of production facility. US-based estimates indicate capital costs for Solar VV built to large utility scales are US$ 2,671/kW, natural gas combustion turbines are US$ 1101/kW, and large-scale biomass is US$ 4985/kW (US EIA, 2016). It is presumed that Zambia's costs would likely be 25% higher than these figures. An IRENA/GIZ analysis suggests hydropower development capital costs in developing countries ranges between US$ 1500 – 5000/kW.[4] Operations and maintenance add costs over the lifetime of the facilities. With Zambia's current power deficit estimated to be in the range of 600 to 800 MW, the investment requirement in generation facilities alone is significant.

1.4 Time requirements:

The development of large scale power production can take several years to implement from conception to commissioning. Lead times in excess of 2 to 3 years can be expected for a single facility, but for the system development at the required scale, longer timescales are necessary.

2. Energy - Distributed energy production

Distributed off-grid (or on-site) energy production refers to a suite of technologies capable of generating power (heat and/or electricity and/or mechanical drive) both close to the source of the energy feedstock and the point of consumption. This option can optimise the use of local feedstocks/energy resources, particularly if relying on forest biomass extracted sustainably. This option also has the benefit of reducing emissions in energy generation if low carbon or

[3] Taking an extreme case, assuming the entire population of North-Western Province (rural and urban) were provided with electricity such that all domestic fuelwood use (637,855 mt DM eq) were substituted for, a total of 387,283 ha could be relieved from all fuelwood extraction (including for charcoal production).

[4] South Africa, Ethiopia, Rwanda and Uganda are the comparable countries. See: https://www.irena.org/documentdownloads/publications/re_technologies_cost_analysis-hydropower.pdf

carbon neutral feedstocks are utilized, can reduce feedstock transport and transmission/distribution investment costs and power losses, can provide multiple forms of industrial and domestic energy requirements, can address energy system outage issues, and helps create formal local employment beyond major urban centres. The use of forest biomass in energy generation technologies allocates an asset value to the forest resource, which creates a 'formalised' opportunity cost to deforestation and forest degradation. If feedstocks from human, animal and suitable industrial/commercial wastes are utilized, there are benefits secured from having a cleaner environment. The available technologies include: solar PV, small-scale hydro electric, biomass gasification, and biogas.

Biogas and biomethane compete in three markets: charcoal, electricity and natural gas, therefore, we focus on biogas options. Biogas facilities can range in size to serve individual households to municipalities, ranging in size from a few cubic metres costing US$52 per m^3 to very large scale installations (45,000 m^3 costing US$ 3,132 per m^3). Typically, Zambian biogas is stored within a biogas system or in plastic containers and used close to the point of production. Biogas can be purified, compressed and sold farther from the production site, but adds cost and complexity to the processing. Compression of biogas into LPG cylinders requires corrosive hydrogen sulphide (H2S), moisture and CO^2 be removed, and the resulting bio-methane gas compressed into a cylinder as compressed bio-methane. This additional processing enables use in vehicles and also for cooking and other domestic or industrial/commercial needs. The higher heat content and sale value of the biomethane can often justify the cost of this additional processing.

2.1 Efficacy in addressing risks/problems:

The range and diversity of decentralised energy solutions requires careful selection based on the availability of 'free' energy resources and feedstocks and the selected approach to reduce deforestation and meet other goals. For example, the installation of an urban waste-water collection system and residential biogas facility provides could serve as a solution to an increasingly urban population faced with growing waste pressures, as well as reducing urban demand for charcoal from biogas production and sales for domestic use. At a smaller scale, biogas facilities at the household level could provide a clean and reliable substitute for fuel wood. Alternatively, small scale gasification units could capture the value of wood chips and sawdust and dry cellulosic plant residues (green waste) to provide electricity to power small scale rural enterprises involved in agricultural and forest product processing. To ensure a sustainable supply of feedstocks would require good management of forest resources.

2.2 Scale of the intervention necessary to have impact:

Most decentralised renewable energy systems including, biogas and biogasification and solar provide considerable opportunity to scale, from small household and village level installations to much larger facilities. The growth in demand for electricity is estimated at between 150 to 200 MW per annum (ZDA, 2014). This would involve very many small projects, providing a high

granularity of intervention, but one with expected high costs and uncertain demand conditions if prices are to reflect the costs of production.

2.3 Costs for investment and implementation:

To match only growing national electricity demand (1.5million MWh per annum) would require investment of over US $175million per annum (assuming a levelized cost of $100 per MWh). Though, this cost would be greater given the enormous efforts that would be required first to conduct technical surveys and designs then to establish both feedstock supply and energy demand markets locally. **Such an investment would only be adequate to cover growth in demand, and would be inadequate to reduce current demand for charcoal and fuel wood.**

2.4 Time requirements:

In relation to the size of the decentralised energy project, they can be complex to establish, especially if it is necessary to develop upstream feedstock logistics.

3. Energy - Sustainable and alternative charcoal

Charcoal is a renewable energy, is locally produced, provides income for local people, and adds economic use value to the forest. Unmanaged charcoal production is a driver of severe forest degradation (FAO, 2017 unpublished). Tighter supply chain control and regulation could promote fuel wood and charcoal in a sustained manner, with all the associated benefits of forest valuation and job creation. The recent Forest Livelihoods Economic Survey (FLES) indicates that at the national level, over 45% of households derive an income from charcoal production, accounting for some 5% of total revenues at household supplier level[5]. In North Western Province, where the production of charcoal is relatively new, these numbers are significantly lower. However, with forest areas in other parts of the country becoming increasingly depleted, charcoal production in North Western Province is already beginning to serve urban demand centres as far as the Copperbelt, Central and Lusaka Province. Demand for woody biomass (for fuelwood and charcoal) in North Western Province is the lowest of all the Provinces in Zambia[6], but can be expected to increase *ceteris paribus* as the population increases. The range of options for strategic investments in charcoal with the potential to reduce forest degradation and deforestation includes:

1. Alternative 'green' charcoal – uses crop residues (usually maize cobs) as a feedstock and a small amount of cassava starch added to help bind the briquettes. Each of the major mines in the Province has developed 'Green' charcoal programs. The production of charcoal from forest biomass is culturally a male dominated activity,

[5] The low levels of income are an indication of the low prices paid to household producers, while middlemen and retailers extract a larger rent.

[6] Total consumption of woody biomass in North Western Province equaled 751 kt Dry Matter equivalent, from a total of 13,038 751 kt Dry Matter equivalent in 2010 (FAO, 2017).

however notably, 'green' charcoal programs have so far included mostly women, which help support family incomes.

2. Sustainable charcoal production – involving improved management of biomass resources (controls on intensity and frequency of biomass extraction); use of more efficient kilns; inclusive business models that increase revenues of households involved in extraction and reduced rent seeking by middlemen and controls on prices to ensure alternative 'modern' energy supplies are not priced out of the market.
3. Improved cookstoves and feedstocks – involving replacement of traditional inefficient 'mbaula' cookstoves with more efficient alternatives, either by replacing the device or the feedstock such as using wood pellets, ethanol, or plant oil.

More needs to be known about the charcoal supply chain in Zambia. This will give clearer picture all along the supply chain, from wood extraction, processing, trade, sales and use. That can then form the basis for market and policy decisions. Simply focusing on one rung in the charcoal supply chain will not affect all the factors that need to be addressed for interventions to succeed. Finding technological solutions to replace wood-based charcoal with green charcoal will not reduce overall demand or efficiency in processing and burning. Similarly, passing legislation for stricter controls of the charcoal market may not necessarily incentivize the uptake of new technology or reduce pressures on forests. All issues need to be addressed in a systematic approach.

What would a systematic approach entail? A highly relevant example is what Rwanda has achieved in its charcoal supply chain, shifting charcoal production from being a major degradation driver in natural forests, to now largely deriving from planted trees (mostly eucalyptus and from agroforestry) (Iiyama et al, 2017). These efforts relied on improving charcoaling techniques for increased efficiency of wood utilization and to improve the quality of the produced charcoal. The Rwandan government also streamlined regulations to develop a more modern and efficient charcoal value chain in the country by making it from "informal" to "modern" sector which could contribute to economic development by raising tax revenues. Another key factor in modernizing the sector was to ensure more value was captured at the producer level (a margin of 33-59% on prices attainable in Kigali). Tenure constraints were not an issue, and sustainable charcoal was promoted as a part of agricultural intensification (*ibid*). In short, a programme for transformation change in Zambia's charcoal supply chain is needed, similar to what Rwanda achieved, but tailored to Zambia's unique circumstance.

While national and regional-level charcoal supply chain analysis for Zambia were not attainable during this research, the 2013 Business Innovation Facility review of the Chongwe-Lusaka charcoal supply chain is informative. They found the most common type of supply chain is when a trader buys directly from a series of producers and then transports the charcoal back to Lusaka for sale. This supply chain type may also dominate in NW Province. Findings indicate that producers earn 44% of the wholesale profits, while their productions costs are negligible. If producers could trade their charcoal directly with the end-market, this would increase their

share of profits. Thus, market interventions should aim for decreasing trader profits and increase profits to producers adhering to sustainable practices (green charcoal, more efficient production, commitments not to deforest). BIF identified that small scale eco-charcoal projects are feasible if they undercut the retail price offered by the supermarkets (though this is the briquette market, and does not include lumpwood charcoal). Importantly, BIF identified that green charcoal can only achieve a small degree of market penetration without larger-scale interventions to transform the majority of the industry. Market transformation will require a strategic plan implemented by the Forestry Department (Business Innovation Facility, 2013).

In many African contexts, charcoal trade is either informal or illegal, and experience shows that improving the supply chain impossible while rent-seeking and corruption proliferate. Therefore, regulating the supply chain, improving legislation and governance, ensuring functioning land and tree tenure, improving the efficiency of charcoal production, and engaging all key actors in the charcoal supply chain is crucial.

3.1 Efficacy in addressing risks/problems:

Green charcoal: The substitution of traditional charcoal with green charcoal depends on various factors, including the price (it must be cheap to compete, but could also lower the price of charcoal products (by adding more supply) and regular availability. The cobs have other uses such as pig feed, so alternatives to feed would need to be identified. It may also lower the opportunity cost of land use change by adding to revenues from maize production, thus increasing agricultural pressures. Using maize cobs for charcoal reduces the quantity available to be composted to maintain soil fertility. While there is no direct financial return on this investment for mines, it has already proven to be a CSR success.

Sustainable charcoal: The production of sustainable charcoal involves the development of sustainable forest governance and management systems, to ensure that extraction rates do not exceed sustainable limits, and the supply chain is regulated. Evaluating the commercial balance (supply minus demand) for North Western province is shown in Figure 6. This shows the towns where demand exceeds supply, and the rural areas and accessible areas where supply exceeds demand (FAO, 2017 unpublished). There is a surplus of 5,799,359 mt dry matter equivalent of sustainably harvestable biomass to supply the fuelwood and charcoal needs of North Western province consumers. Total household demand for fuelwood and charcoal per annum is 637,855 mt dry matter, which is approximately 11% of potential supply. However, as local forests deplete charcoal provision from North Western Province to major urban areas of Zambia will become increasingly linked. Total demand for charcoal across Zambia is 13,037,667 mt dry matter (FAO, 2017) which is far in excess of the forests of North Western Province to supply sustainably. Finding solutions that all stakeholders can buy into—including farmers, charcoal producers, transporters, vendors, retailers, consumers, government—**requires dialogue and agreement on a transformative approach to charcoal production at the national scale. Partnership and strategic investments by mining companies can be crucial leverage to bring capacity and political support for bold action, and also embeds current**

CSR green charcoal programmes in a much more impactful context. Thus, investments by mining companies toward charcoal transformation can be the catalytic investments that transforms the scale of their current CSR interventions, and achieves outcomes far beyond what their CSR interventions could achieve. Stakeholders will have interest to transforming the charcoal sector because there are benefits at all levels: farmers and local people will sustainably produce wood, charcoal producers will earn more, transporters, vendors and retailers will spend less on shadow taxes and bribes, consumers will receive a better and potentially cheaper product and the government will receive tax revenues and address the forest degradation from charcoal production. With a growing population depending to a large degree on fuel wood and charcoal, this has long-term benefits.

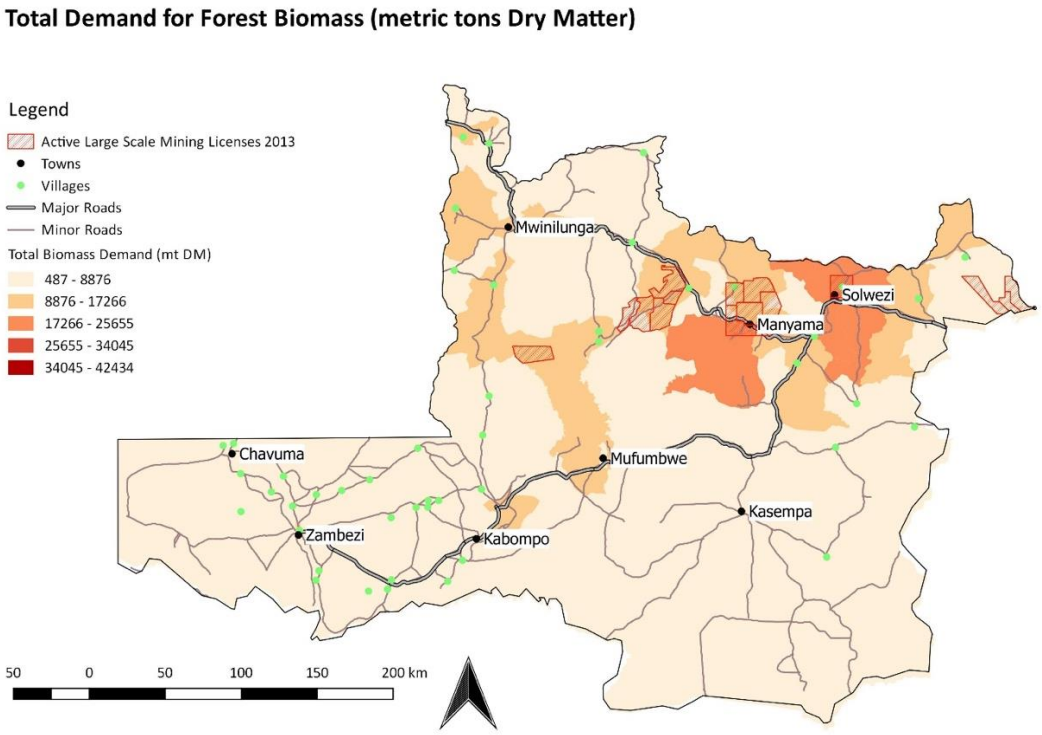


Figure 5. Total demand for forest biomass at ward level

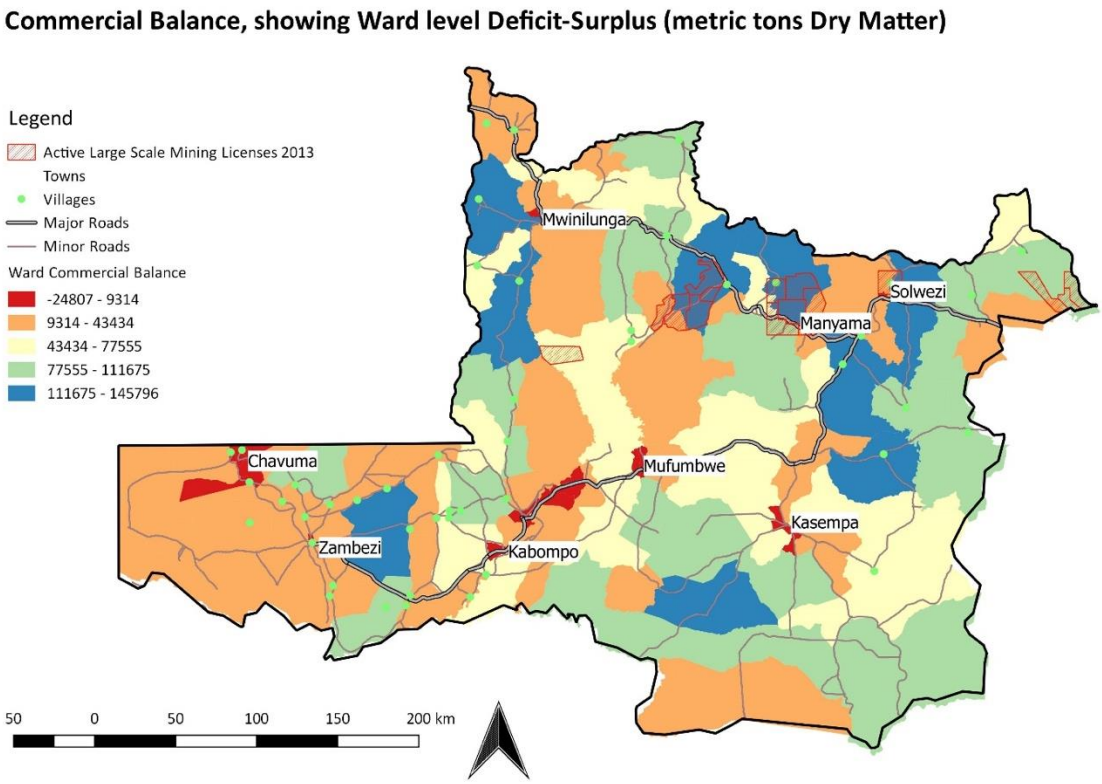


Figure 6. Commercial balance showing Ward level deficit-surplus (mt Dry Matter)

Improved cookstoves and feedstocks: Cookstoves improve the end-use efficiency of fuel use. They come in a variety of forms, from homemade earthenware rocket stoves suitable for use with wood and charcoal, to more elaborate systems capable of charging phones as well as cooking. Typical improvements in fuel use efficiency are in the range of 20% to 80% depending on design and the type of feedstock used. Each stove type typically has a specific alternative feedstock. Fuelwood makes up the largest demand for forest energy products nationally, being a little over 6 million metric tons DM annually. A small increment in efficiency of fuelwood use therefore corresponds to a significant reduction in demand[7]. While crop production for biofuels offers benefits of a new potential market for farmers, growing markets for crops can intensify deforestation, and could also compete with food crop production, which carries high risk in this region. An exciting alternative is to generate feedstocks (charcoal substitute pellets, biogas feedstocks, pure plant oil) on degraded mine facilities as part of the revegetation activities:

[7] A 20% reduction in demand for fuelwood corresponds to eliminating 1,227,868 mt DM per annum, some 745,518 hectares of forest required (at 1.647 mt ha year mean annual increment) or approximately 12,000 hectares clear cut (assuming average 100 mt DM per ha).

- *Wood pellets:* Waste sawdust from timber and pulp and paper operations as well as chipped energy crops (such as *Gliricidia*) when pelletized can substitute for charcoal. The cost of wood pellets is offset by increased efficiency.

- *Ethanol*: Feedstocks include cassava, sweet potatoes, sweet sorghum and water melon, and can be grown in crop rotations or for continued land productivity. Ethanol is ZMW 10 per litre, which can also be sold in any fraction, which is comparable, and therefore competitive with charcoal.[8]

- *Plant oil*: To overcome the food/biofuel trade-off and to address the increased deforestation risks from growing biofuel crops, two options are relevant: cultivating non-edible tree crops as part of an agroforestry based system, or to develop non-edible oil producing plantations on degraded mine sites – such as tailing storage facilities and overburden – otherwise unsuitable for crop production. These activities can be part of on-going mine site rehabilitation activities. Jatropha can be planted along field boundaries, in agricultural soils, but lacks the ability to fix nitrogen and produces poor oil yields under stressed (drought and soil salinity) conditions, therefore is not a suitable candidate for agroforestry or mine rehabilitation in the region. Non-edible oilseed producing tree Elite *Pongamia pinnata* offers an alternative. It fixes nitrogen, is drought and saline tolerant, capable of producing yields of 3,000-7,000 litres per ha of oil, 25 tons of charcoal substitute per ha[9]. With several thousands of hectares of disused tailings storage facility already requiring on-going rehabilitation. A 1000-ha rehabilitation project would cost $10 million and generate annual returns at maturity of over $11 million, producing 14,000 mt of organic fertiliser (adequate for 1000 ha maize production fertiliser needs) or 66,000 MWh of biogas feedstock. Also, over 162,000 MWh of charcoal substitute from podshells, which can substitute for 36,000 mt of fuel wood, which would require 21,858 ha of forest to come under sustainable management for fuel wood extraction, incurring significant additional costs in aggregating feedstocks.

3.2 Scale of the intervention necessary to have impact:

Green charcoal: Maize production in North Western Province has increased very rapidly over the past 20 years (13,339mt per annum between 2005 and 2014). In 2014, production was 160,866 mt of maize.[10] Extrapolating this to 2017, we estimate production to exceed 200,000 mt, which would result in roughly 9,600 mt of charcoal.[11] This quantity of alternative charcoal could substitute for between 13% and 26% of total charcoal demand (roughly 36,858 mt) in North Western Province depending on the efficiency of the process

[8] The smallest charcoal unit (sachet) is ZMW 5 in Solwezi, and households using charcoal for cooking usually consume mostly ZMW 15 to ZMW 20 for larger families, per day. The cost of ethanol is ZMW 10 per litre, A family of five can use about 1 litre per day (ZMW 10/day) or less. A litre burns for 4.5 hours at maximum heat and 9 hours at minimum heat.

[9] As well as other valuable by-products: organic fertiliser, bio-pesticides, mosquito larvicides, karanjin for medical purposes.

[10] http://zambia.opendataforafrica.org/ionawve/agriculture-statistics?tsId=1000470

[11] 200,000 metric tonnes of maize corresponds to 38,570 mt (dry matter) of cobs (assuming 20% moisture content of cobs at harvest), and we assume a 25% recovery rate utilized for green charcoal production.

(10% to 20% efficient). Assuming the production of alternative charcoal substitutes for sustainable production of charcoal (at a take-off rate of 1.65 mt DM ha), then approximately 23,000 ha of forest can be taken out of charcoal production. Clearly, as maize cob alternative charcoal production is unable to meet the entirety of North West Province charcoal demand, it is unlikely that it would be transported out of the region to substitute for unsustainable charcoal demand elsewhere in the country. Regardless of demand it is unlikely that all maize cobs could ever be used as a charcoal substitute as farmers have other uses for them (for example lighting stoves.) More importantly, such an intervention would have to extend across all maize production areas (6,400,000 ha in North Western Province alone) which is unfeasible unless innovative methods are employed to ensure uptake and scalability.

Sustainable charcoal: To scale these operations, it is essential to develop the system of sustainable forest management, to ensure a level playing field, and that unsustainable charcoal suppliers cannot undercut the market. These are further discussed in the Governance section. Also required is to design an approach national in scale, bringing in all relevant stakeholders. Assessment of the scale of the intervention should derive from an analysis of market demand, local/regional/national patterns related to demand, and pricing aspects. This can be complemented with approaches to identify how to scale uptake in the region, by creating cooperatives or community hubs (to help enforce sourcing commitments related to natural forests, to establish cooperative kilns more efficient than existing ones, to collectively market products, etc.).

Improved cookstoves and feedstocks: Achieving scale in alternative feedstocks and improved cookstoves requires focus on both upstream supply of feedstocks and sale of improved cookstoves. The potential for scaling in each fuel/stove combination is constrained by the availability of the feedstocks. The use of existing crop production as feedstocks, such as cassava, offers an immediate advantage because supplies of feedstock can be readily procured, but poses a longer-term threat as market driven growth leads to increased land use change to agriculture. Plant oil production would require investment to develop feedstock supplies, but can be developed in line with mine site rehabilitation plans or as part of agroforestry schemes to avoid additional deforestation or competition with food production.

3.3 Costs for investment and implementation:

Green charcoal: The costs of establishing a green charcoal production facility on a small household scale are very low. However, the costs for implementing a project to develop green charcoal at scale could be considerable, unless adoption is by word-of-mouth.

Sustainable charcoal: Presently the only example of commercially available sustainable (or eco-charcoal) in Zambia is run through a public private partnership between the forestry Department, a commercial venture BioCarbon Partners and USAID. The establishment of sustainable charcoal value-chains typically involves the establishment of community managed forests, improved kiln technology, a supply chain and marketing activities. The

costs of establishment of such are proprietary, while the retail price of a bag of eco-charcoal is approximately 5 to 15% above the standard market rate. At present most consumers that are willing to pay a premium are based in Lusaka. As Rwanda's experience illustrates (and BIF's recommendation in their Chongwe-Lusaka charcoal supply chain analysis), this option is maximized only when enabling policy and governance aspects are put in place. Thus, the public sector costs are ideally mobilized by ODA or new sources of finance to support government action in such a transformative endeavour.

Improved cookstoves and feedstocks: All have different cost structures:

- Wood pellets: The landed wholesale price of a wood pellet stove is approximately 250 ZMW, retailing at 300ZMW. The production cost of wood pellets is ZMW 1200 per tonne, retailing at double the amount (not including VAT). Average consumption of wood pellets per month is 30kg, a total cost to the household of 800 ZMW per month. Feedstocks for wood pellets can be sourced from crop residues. As an example, 1 ha of pigeon pea generates 2 mt of stalks (dry matter equivalent) and therefore 2 mt of pellets, capable of providing enough fuel for 10 families per annum.
- Ethanol: A complete ethanol production modular start-up plant costs US$ 200,000 and can produce 50 litres per hour (or, 312,000 litres per year, 20 hours/day, 312 working days/year. Cost of ethanol production is about US$ 0.64/Litre, but costs depends on the feedstock used and production energy system applied. Feedstocks include cassava, sweet potatoes, sweet sorghum and watermelon. This is to allow for crop rotation or integrated feedstock production for continued land productivity.
- Plant oil: The benefit to mines of promoting non-edible oil producing tree plantations on degraded mine sites that are unsuitable for crop production that it transforms rehabilitation costs into a revenue-generating and livelihood-supporting activity. It can also create jobs for the post-mining economy. Barrick has completed some research and development on crop diversification and agroforestry which can be applicable. The costs of establishing 1 ha of plantation on a tailing storage facility is roughly US $7,000[12]. Processing machinery costs (including all vehicles and fixed assets) equate to US $4,000 per ha. The production cost of plant oil is $0.48 per litre. Returns from sales of by-products render the project profitable, whilst contributing to sustainable agricultural intensification through provision of organic fertilisers, bio-pesticides and animal fodder. Put into the context of a 'typical' mine site in North Western Province, where the areal extent of degraded land can be 1000 ha, the total investment cost for complete rehabilitation with non-edible plant oil would be $11M, creating at least 500 full-time long-term jobs in plantation management and processing. Total production quantities of oil (which can also be converted to biodiesel) would exceed 6M litres (equivalent to 300,000 MWh per annum), 35,000 tons of seed podshells to be used as a

[12] Importantly this investment can be offset against known costs of TSF rehabilitation which using standard methods can be in excess of the proposed activity using Pongamia trees.

charcoal/biomass substitute (167,737 MWh) and 14,725 tons of pressed seedcake (65,000 MWh)[13].

3.4 Time requirements:

Changing the way people cook involves changing behaviours at a fundamental level. To speed this process the degree of incentivization and the 'costs' of changing technologies must be low. The interventions described above vary and can be done household by household in the case of teaching production of green charcoal, but unless adoption 'goes viral,' it will take repeated interventions across a very large landscape. Similarly, the development of a nascent bioenergy production system on degraded mine sites will take at least a decade to mature.

Intervention 2 - Agriculture

One of the primary drivers of deforestation in North Western Province is change of land use from forest to agriculture. The average rate of deforestation in North Western Province is 2% per annum. Between 2010 and 2014, 1.89 million hectares of forest were lost to land use change for agriculture. New mining developments, the associated influx of people, and the growing demand market for agricultural produce, indicates this trend will continue, and this directly and indirectly puts pressure on mine operations.

Technological solutions to intensify agriculture production sustainably exist and are viable options, if there are simultaneous measures put in place to limit agricultural expansion. Given the nature of the soils, the wet-dry climate and potential climate change the development of climate smart agriculture is a priority. Similarly, efforts are required to maximise the potential of existing forest to produce food, through forest game ranches and the development of non-timber forest product markets. By so doing the opportunity cost of land use change and deforestation is increased.

Table 2. Cross-tabulation matrix of land use change between 2010 and 2014, North Western Province[14].

Units: hectares						
	Forest	**Grassland**	**Cropland**	**Wetland**	**Settlment**	**Barren Land**
Forest	95,826,902	-	1,896,331	-	-	-
Grassland	-	33,801,509	-	-	-	-
Cropland	-	-	4,542,272	-	-	-

[13] Note: all MWh energy values are pre-conversion to useful work and therefore do not reflect final energy service delivery substituting for electricity. Therefore at 33% efficiency of use the energy delivered from podshells would equal 55,000 MWh)

[14] This table shows total cover of each land use on 2014 in the diagonals and the change from one type to another in the upper right half of the matix.

Wetland	-	-	-	2,086,786	-	-
Settlment	-	-	-	-	125,056	-
Barren Land	-	-	-	-	-	130,603
Total	95,826,902	33,801,509	6,438,603	2,086,786	125,056	130,603
Deforestation Rate:		**2% per annum**				

Source: ILUA II

The clearance of forest for agriculture is concentrated on customary land, not on mine license areas, and there is increasing evidence of incursion into protected forests. Traditional leaders are under significant pressure to allocate land to households from the communities they represent, as well as newcomers to the region. To a considerable extent this land use change is both unplanned and unmanaged. The principle crops grown are maize, cassava and sorghum. Yields are typically low, rarely exceeding 2 metric ton per ha for maize. Possible intervention options include:

1. **Climate Smart Agriculture and agroforestry** – applying appropriate technologies for appropriate land management and crop production methods, such as cover crops, inter crops, minimum tillage, mulching and agroforestry. While standard approaches to agricultural intensification rely on the increased use of inorganic fertilisers, herbicides and pesticides, appropriate climate-smart agriculture technologies for rural small holders in Zambia rely on best use of available resources, such as composting and the integration of nitrogen fixing crops into the crop cycle. These are 'low cost' interventions designed to enable farmers to increase their yields sustainably and to maximise their revenues.
2. **Forest game ranches** – involving the development of markets for bush meat and animal products, including breeding stock. Requires set-asides and 'no-go' areas for mining to maintain habitat.
3. **Non timber forest product markets** – involving the production of new crops for which there is demand and the development of demand markets and mechanisms to connect producers to markets for existing forest products.

Both Barrick and First Quantum Minerals have developed climate smart agriculture programs, to enable farmers to increase arable yields sustainably. Some efforts have been devoted to diversifying crop production away from maize, to increase harvests of drought resistant crops such as cassava and sorghum, also tree crops (primarily citrus) within agroforestry systems. A major focus of First Quantum at Kalumbila has been towards the re-introduction and development of viable populations of native ungulate herds, with a view to enabling sustainable harvest of game meat (and the future development of eco-tourism).

4.1 Efficacy in addressing risks/problems:

Climate-smart agriculture: While benefits to agricultural production and soil health are clear, without linking this to stricter controls on land use change and setting aside areas from

expansion, the factors driving extensive agriculture will persist and further deforestation will occur.

Forest game ranches: This option promotes economic value of the standing miombo woodland, while still serving needs for protein, so has high potential for incentivizing forest retention. Cultural aspects are also important, as traditionally local people in North Western Province were hunter-gatherers, but this activity is now illegal without permits, which are too costly for local people. By restoring the wildlife (and cattle) populations to the forests and dambos, employment opportunities for legal local hunting and wildlife management could be created. Under good governance and management the deleterious effects of poaching to reduce populations to critical levels can be eliminated. Further, new sources of income in eco-tourism could be developed.[15]

Non-timber forest product markets: Forest protection allows for the capability of the forest to produce a wide-range of non-forest products. When members of the local community are successfully generating revenues from NTFP's such as honey, caterpillars, mushrooms they are strongly incentivised to protect the forest from unsustainable practices such as illegal charcoal production or logging.

4.2 Scale of the intervention necessary to have impact:

Climate-smart agriculture: This is already being developed in the region by a range of NGO/CSOs and mining companies. The interventions include workshops and training, often through 'lead farmers', potentially reaching farmers managing some several hundred hectares at most. These activities would need to be dramatically scaled up to reach a larger portion of NW Province farmers, and linked with stricter controls on land use change and setting aside areas from expansion (these could be through agreements with regional government, chiefs, mining companies).

Forest game ranches: These woodlands provide grasses suitable for local wild species but also cattle herds. South Africa provides a comparable example of potential benefits from wild game and wildlife ranching, which have saved species from extinction, helped conserve ecosystems. The scale need to be determined, and would require additions to existing Game Management Areas and Protected Forests.

Non-timber forest product markets: This is an additional category of use and benefit from forest game ranches or set-asides. A 2008 post-harvest survey of rural households in Zambia found that income from NTFPs comprises roughly 14% of total household income (Mulenga et al, 2012), though this is likely an underestimate, as fruits, health products or cultural services were not considered and the potential for revenue generation from exports of honey and other goods is increasing, causing demand for these products (for example, honey) to increase.

[15] While a long-term goal, FQM has invested in airport facilities to facilitate this development.

4.3 Costs for investment and implementation:

Climate-smart agriculture: The costs of such interventions vary widely. According to available CSR spend data for mines in Zambia (Chamber of Mines, 2017b), these costs do not exceed $50,000 per annum (not including costs of vehicle purchase), however actual spends may be larger and unreported. The communities targeted are those in the immediate proximity of the mine. If this was scaled up to reach more farmers, the costs would correspondingly increase.

The **benefits of such interventions to the mines** must be considered in terms of 'intangible' goods such as risk management and good community relations. **The benefits for individual farmers and the public are much more evident.** As a simple example, through effective regenerative farming practices farmers can shift from a loss-making situation, to one of profit. An over-simplistic scaling of these potential returns to the Province, based on current land use data indicates that the region could generate revenues in excess of $1.8 billion (see Annex, Table 3). Agroforestry provides another means to increase revenues for small farmers. Importantly such systems can also contribute to sustainable energy provision, reducing pressure on forests for local livelihood needs and revenue.

Forest game ranches: In South Africa, wildlife ranching covers 170,419 km^2 (17 million ha), and provides strong economic value. In 2014, total revenues from live sales were US$326 million, biltong hunting revenues were US$49 million and culling for meat generated revenues of US$26 million (Taylor et al, 2015). There is considerable scope for development of a similar sized industry in Zambia. Lacking Zambia-specific data, average per hectare revenues from five game ranch activities documented by Taylor et al (2015) for South Africa were used to extrapolate an estimate of revenues based on existing Game Management Areas (GMAs) and Protected Forests (4,057,578 ha) indicating that over $223 million of revenues could be generated on existing areas already set aside. If new areas were set aside, this revenue projection would increase accordingly.

Non-timber forest product markets: Many of the products have a potential demand and value in markets beyond the immediate vicinity of the forests, though these have not been developed. The best example is the honey market, which is the most developed of the NTFP markets in Zambia. In April 2017, five Zambian companies received permits to export Zambian honey into International markets, and this could be done for other commodities, such as fruits, mushrooms, caterpillars and medicinal products (bark, leaves, herbs). While a potential revenue per hectare estimate is not available, Turpie et al's (2015) analysis of forest ecosystem service value provides an estimate based on current extraction patterns in Zambia. Based on Turpie et al's higher value ($9 USD per ha) awe estimate that NTFP revenues generated could exceed $860 million per year in North Western Province. However, that is without identifying the primary products, so is a loose estimate, and could

be an underestimate if suitable investments are made in aggregation, logistics and marketing.

4.4 Time requirements:

Climate-smart agriculture: It takes a considerable amount of time and effort to foster change in agricultural production systems. Farmers are risk averse, need to see immediate returns on their efforts unless otherwise convinced and incentivised by first hand experience, from a trusted and proven source. Empirical evidence on adoption of CSA is limited in scope, but suggests that adoption rates have remained low (between 3 to 13%) despite considerable long-term, costly efforts. This is perhaps because of weak incentives for adoption. For example, the market does not offer a price premiums for CSA products.

Forest game ranches: South Africa's example indicates returns on capital investment across a range of activities including disease-free buffalo breeding and intensive sable breeding are estimated to range from 43-60% after 10 years (Dry, 2015).

Non-timber forest product markets: Anecdotal evidence from a recent project to foster private sector led market expansion for non-timber forest products involved taking suppliers to the markets they served to gain evidence of the prices they may be able to secure. Once they understood the benefits of transporting goods to market they have rapidly adopted the approach and are now actively concerned with the long term viability of the forest that supplies them their product. At an individual level change can be fast, but to reach scale then a certain degree of formalisation of forest governance structures and market mechanisms is required. There is significant potential for these projects to piggy back on the creation of CBNRM governance structures and to benefit from the development of internet enhanced markets and logistics facilities to ensure better access to wider markets.

Intervention 3 - Governance

Effective governance will determine the success of many of the investment options discussed above, such as sustainable charcoal, conservation set-asides from mining and unplanned human encroachment and ensuring communities participate effectively in the development decision-making process. Good governance is required to ensure democratic, equitable participation in decision-making, to ensure prior informed consent for new projects and to enforce and uphold the rule of law, including the results of collective decision-making on land use zoning and usufruct rights. The availability of Government resources for such activities is limited. Historically mines have engaged in supporting Government in the provision of various services (typically health and education) and increasingly have become involved in assisting Government in protecting forest and wildlife resources. Communities and traditional leaders have very limited resources to advocate for community interests and assist in natural resource governance. Mines identify the risks of inadequate governance include security risks, incursions from adjacent forests into mining sites, and conflicts with local communities. Mines have the resources and staff to carry out natural resource governance functions, yet to do so requires

productive partnerships with government and local communities. Possible intervention options include:

1. **Advocacy** – Providing communities with the means to meaningfully engage with mining companies in the process of Free, Prior Informed Consent;
2. **Resource conservation and land use zoning** – involving the development of mechanisms to identify vital natural systems (forests, wetlands, aquifers, biodiversity) and ensuring their long-term protection from land use change and degradation.
3. **Community forest management** – establishing Community Based Natural Resource Management (CBNRM) groups;
4. **Direct support to Government Institutions (Forestry Department and ZAWA)** – formalized agreements with Government for the shared financing and capacity for protected area management.

Efficacy in addressing risks/problems:

Advocacy and voice: This is a critical enabling element to support the intervention options. Communities, traditional leaders and government authorities have little experience in North Western Province in engaging with large international corporations concerning development plans. Mining companies it is essential to ensure they have the means to engage fairly and equally in discussions, negotiations, planning and decision-making activities.

Resource conservation and land use zoning: Most of the investment options in this report require some form of integrated land use planning to delineate zones those areas where land use change is acceptable and where the natural vegetation cover should be conserved and managed. Various inputs from stakeholders will be essential, including from mines, government agencies, and communities. We propose participatory 'forest ecosystem service valuation' first done by UNEP at a national scale (Turpie et al. 2015) and 'high conservation value' mapping, which has been completed for Eastern Province, and enabled local communities and stakeholders to participate in an iterative group mapping process (Warr, 2016). This could be combined with options analyses driven by investment scenarios to determine the level of revenue streams from forest services and products required to disincentivise land use change (Sarrado and Warr, 2009). It could also serve as the basis for land protection and biodiversity offsets whereby a mine pays to protect an area of threatened forest equivalent in size, biodiversity and ecosystem service provision to the one they will convert for mine operations.

Community forest management: Presently, communities are unable to stop people from entering forests and extracting resources or changing land use to other uses due to lack of clarity in their tenure rights. Yet communities express interest in the right to exclude 'opportunistic' extraction and communities could be land stewards, if they had the responsibility and control necessary. The new Forest Act (2015) provides for Community

Based Natural Resource Management (CBNRM), allowing communities to apply for this tenure right, develop sustainable utilization plans and exercise controls on forest use.

Scale of the intervention necessary to have impact:

Engagement for advocacy, land use mapping and zoning, as well as establishment of community forest management must be conducted with adequate granularity determined by the structure of local communities and ecosystem variability, but at a regional scale, capable of providing a clear overview required for sustainable integrated land use management.

Costs for investment and implementation:

Advocacy and voice: The number of Civil Society Organisations in North Western Province is very limited. This is partly due to the very new nature of the threats and challenges they are seeking to address, as well as the lack of resources. In the face of such rapid change Traditional leadership structures are unable to respond on all issues without adequate support. Collectively, new and incumbent mines and other projects in the region need to consider the importance of providing consistent reliable and impartial funding to support communities in their efforts to understand and react to change. While not an investment *per se* a collective funding from the private sector to assist in the systematic dissemination of information to and collection of views from communities is essential. Without coordination, occurring in a haphazard manner, any engagement will fail to address systematically the issues raised in this document.

Resource conservation and land use zoning: The ILUA I and II projects have increased significantly the availability of suitable data and procedures for mapping. It is possible to develop draft Forest Ecosystem Service Valuation and High Conservation Value maps using just this data, however it is essential that any resource valuation, conservation and land use zoning exercise be accompanied by additional research specifically into non-timber forest product dependence and value chains and include a significant participatory component. Since the first Forest Ecosystem Service Valuation study (Turpie et al 2015), the availability and quality of data has significantly improved, suggesting that this effort should be repeated involving some additional fieldwork to improve estimates of critical parameters and obtain valuable ground-truthing information. The costs of undertaking such an exercise would be less than $150,000. Subsequent engagement with communities and development of agreed upon land use zoning would require significantly larger financing.

Community forest management: A Finish-funded project is indicative, as it has established over 27,000 ha of Community Forests at a total cost of US$4.3 million over 3 years in its first phase, and thus an average cost of $160 per hectare (including technical assistance). Engagement activities (e.g. stakeholder meetings with communities, Traditional leaders and Government) can have a fixed cost per community, whereas the costs of implementation with each Community Forest vary considerably. Approximately US $2

million of this cost was for technical assistance, with the remainder providing for support vehicles, fuel and support to Government in the region. Follow-up investments are necessary to support the CBNRM structures and provide access to finance for investments in forest revenue generating activities.

Direct Support to Government Institutions: Wait for Mr Makumba's feedback.

Time requirements:

Any process that involves significant engagement, improving governance structures and/or achieving consensus in land use zoning is going to take considerable persistence and time. Participatory mapping can provide an important structure to this engagement process, providing not only the hard data required to inform decisions, but also the common-stage for sharing information and incorporating (disparate) viewpoints. Importantly the mapping can be done in iteratively to be refined and modified with increasing resolution. To complete an initial mapping of North Western Province forest ecosystem service and high conservation values could take 6 months ($150,000). The subsequent process of refining and zoning these maps, incorporating stakeholder consultation, could take many years for the entire region. However, importantly targeted analysis can be completed for specific areas of new developments quite quickly using the original analysis as a baseline.

5. CONCLUSIONS AND RECOMMENDATIONS FOR ACTIONS TO BE UNDERTAKEN BY THE MINING SECTOR AND FOR INCLUSION IN THE REDD+ INVESTMENT PLAN

The Government of Zambia has identified three pillars of investment priority, to support its REDD+ and INDC forest sector goals: community forest management (related to customary lands), forest management for improved livelihoods, and sustainable agriculture which improves yields while limiting expansion into forest areas.

The main direct drivers of forest degradation are charcoal production and illegal timber extraction, while drivers of deforestation are primarily agricultural and human-settlement expansion (Turpie et al, 2015). Mining activities play a key role in driving these activities, though there are regional and historical differences in forest transition patterns. In North Western Province, mining is the primary economic activity that enables these key drivers of deforestation and forest degradation. Mining companies are perceived to be responsible for these risks, given their significant role in the region and the lack of governance. This affects their social license to operate. **The priorities identified below define key investments that the mining sector can make to address key risks and help leverage public benefits within their operating region. This is framed within the context of an overall package approach, in which mining company investments are leveraged and reinforced by multi-lateral investments.** The

central role of government and close coordination with mining companies will be crucial to drive innovative practices by the mining sector to support integrated land management solutions.

Both mining companies identify a need to think beyond the scope of the mines' direct operations, to include communities and the region, as a whole. For Barrick, influx management is the top priority concern, which includes security, water and sanitation, but also includes impacts on forests, due to charcoal harvesting and burning due to increased influx. Barrick CSR staff identify there is strong scope for partnerships on charcoal, given the scale of the challenge, and how integral it is to the influx issue. First Quantum Minerals shares this interest at its Kansanshi site, seeing surrounding forests now serving a national demand for charcoal, and Illegal timber extraction causing impacts. Kansanshi's CSR Department has worked with local communities on conservation farming, beekeeping and green charcoal, and views its social license to operate as being dependent on meeting these needs. The Kalumbila mine provides a model for how shared forest management and game restocking can protect forest values.

Based on assessment of mining operations and interviews with mining companies, the following is **proposed as prioritized options, within a package approach**:

The suite of investment options must be viewed as a package, which contains the following:

1. Defined "no-go" areas: An anchor of high conservation value lands set aside from future development and agreed to by all parties

A landscape approach for evaluation of highest priority "no-go" areas for mining is an anchor of this package approach, and should be identified through a dialogue process with local communities, the Forest Department, ZEMA, Ministry of Mines, and then legislated. The process can also identify areas suitable for potential future mining and urban expansion. Attention should be put to developing livelihood benefits from the ecosystem services of the "no-go" areas, such as game parks, NTFP collection, and other uses, as appropriate. Implement the Initiative for Responsible Mining Assurance provision 3.8 on biodiversity outside protected areas[16] on the basis of no net loss or a net gain of biodiversity in the context of mine siting and associated development (Anglo American and Arcelor Mittal are involved in IRMA). Further, the International Council on Mining and Minerals principle on biodiversity can also be a guide for mining company action.[17]

Mining company investment: no direct cost at this time, as "no-go" areas would come from future expansion potential, which may or may not contain viable mineral deposits. Minimal costs to support public-private partnership for management.

[16] For more detail, see: http://www.responsiblemining.net/irma-standard/irma-standard-draft-v2.0/chapter-3.8-biodiversity-outside-officially--protected-areas/

[17] See: https://www.icmm.com/en-gb/environment/biodiversity/managing-biodiversity

Public sector/multi-lateral investment: Support for capacity to manage "no-go" areas, capacity-building for local community stewardship.

2. Energy: A regional, and perhaps even national, approach to regulate charcoal and encourage sustainable charcoal production + improved cookstoves and feedstocks:

A systematic approach to improve charcoal production and decrease pressure on North Western Province forests is necessary. The approach should combine: a) alternative 'green' charcoal based on crop residue use (e.g. maize cobs) as a feedstock, b) improved cookstoves and feedstocks (such as wood pellets, ethanol, or plant oil), c) supply chain interventions to ensure positive interventions are not undercut in the marketplace, d) legislation for stricter controls of the charcoal market to shift it from an informal sector to a modern sector. Identifying solutions **requires dialogue and agreement on a transformative approach to charcoal production at the national scale,** including all stakeholders including farmers, charcoal producers, transporters, vendors, retailers, consumers, and government**. Partnership and strategic investments by mining companies can be crucial leverage to bring capacity and political support for bold action, and also embeds current CSR green charcoal programmes in a much more impactful context.** Improving sanitation conditions and market hygiene by installing community and household biogas latrines can also be supported.

Mining company investment: An anchor investment, to be complemented by multi-lateral.

Public sector/multi-lateral investment: TBD

3. Agriculture: Climate-smart agriculture, game and non-timber forest products can solutions to intensify agriculture production sustainably exist and are viable options, if there are simultaneous measures put in place to limit agricultural expansion.

Mines can build on the climate-smart agriculture interventions they are already undertaking, but scale up these efforts through partnerships. Forest game reserves and ranches hold the greatest promise of safeguarding forest areas, and also providing alternative forms of income from standing forests. Mining companies can partner with government and communities to identify suitable areas, and set these aside as 'no-go' areas, while partnering on strategic investments to carry out activities (First Quantum Minerals efforts are a model to build upon). Game ranches require investment of several to tens of millions of dollars. Extrapolating revenues from similar areas in South Africa, we estimate that the revenue potential could be over $223 million, which could be generated on existing Game Management Areas (GMAs) and Protected Forests (4,057,578 ha). With areas set aside, this revenue projection would increase accordingly.

Mining company investment: TBD, to be complemented by multi-lateral.

Public sector/multi-lateral investment: TBD

4. Governance: Supporting improved governance through partnerships and investments

Public-private partnerships can be pursued for investment in the energy and agriculture interventions above. A platform for dialogue and support for communities to express their vision for the region through the process of Free, Prior Informed Consent is crucial. Capacity assistance to support resource conservation and land use zoning in the identification of 'no-go' areas will be required. Capacity support to develop community forest management, particularly through Community Based Natural Resource Management (CBNRM) groups is crucial. Direct support to Government Institutions (Forestry Department and ZAWA) can also be considered. Mining companies should apply all 8 International Performance Standards on Environmental and Social Sustainability.

Mining company investment: TBD

Public sector/multi-lateral investment: TBD

Parallel investments (not directly within forest areas):

Two other large scale investments include central 'utility' scale and decentralised electricity generation, required for mine use and potentially providing surplus power to the grid. These are not interventions within forests, and lack the community engagement and involvement of other options. These options are of increasing interest to some mining companies, given the recent increase of 75% in the electricity tariff. However they could offset increased demand for charcoal, in communities served:

- Large-scale centralised energy production: While such capacity would help serve the power supply demands of mines and support community access to electricity, capital costs are considerable, and this option may have limited impact in replacing charcoal demand.
- Distributed energy production, including biogas: However, investments of over US $175 million per year would be required, and this would likely only cover growth in demand, and be inadequate to reduce current demand for charcoal and fuel wood.

References

Barrick Gold Corporation, 2016a. Annual information Form (For the year ended December 31, 2015 Dated as of March 28, 2016).

Barrick, 2016b. Driven by Returns. Lumwana CSR Overview.

Barrick, 2015. Responsibility Report.

Barrick Gold Corporation, 2012. Annual Information Form (For the year ended December 31, 2011, dated as of March 28, 2012).

BMI Research, 2016. Zambia Mining Report, Executive Summary. Published 01 Oct 2016.

Business Innovation Facility, 2013. Can commercial solutions make charcoal in Africa sustainable? Value chain analysis to inform eco-charcoal programme design and prevent forest degradation in Zambia.

First Quantum Minerals, 2015a. Annual Report

First Quantum Minerals, 2015b. Trident Sentinel and Enterprise Mines. Introductory presentation, 28 August 2015.

Government of the Republic of Zambia, 2016. An Act to amend the Mines and Minerals Development Act, 2015. Act No. 14 of 2016.

Government of the Republic of Zambia, 2015(a). National Strategy to Reduce Emissions from Deforestation and Forest Degradation (REDD+). Forestry Department, Ministry of Lands, Natural Resources and Environmental Protection.

Government of the Republic of Zambia, 2015 (b). Zambia Mining Sector Profile. Zambia Development Agency.

Government of the Republic of Zambia, 2015 (c). The Forests Act, 2015.

Government of the Republic of Zambia, 2015(d). INDC. Zambia's Intended Nationally Determined Contribution (INDC) to the 2015 Paris Agreement on Climate Change.

Government of the Republic of Zambia, 2015 (e). Zambia Living Conditions Monitoring Survey.

Gumbo, D. J., Moombe, K. B., Kandulu, M. M., Kabwe, G., Ojanen, M., Ndhlovu, E. and Sunderland, T.C.H. 2013. Dynamics of the charcoal and indigenous timber trade in Zambia: A scoping study in Eastern, Northern and Northwestern provinces. Occasional Paper 86. CIFOR, Bogor, Indonesia.

Iiyama, M., H. Neufeldt, M. Njenga, A. Derero, G.M. Ndegwa, A. Mukuralinda, P. Dobie, R. Jamnadass, J. Mowo, 2017. Conceptual Analysis: The Charcoal-Agriculture Nexus to Understand the Socio-Ecological Contexts Underlying Varied Sustainability Outcomes in African Landscapes. Front. Environ. Sci. 5:31. doi: 10.3389/fenvs.2017.00031

Office of the Auditor General (OAG). 2014. Report of the Auditor General on the management of environmental degradation caused by mining activities in Zambia. GRZ.

Senior Chief Musele and Kalumbila Minerals Limited, 2011. Agreement between His Royal Highness Senior Chief Musele and Kalumbila Minerals Limited, a subsidiary of First Quantum Minerals Limited for the Acquisition of Surface Rights within the Chiefdom of Senior Chief Musele for the Trident Project of approximately 518 square kilometres. REF: TRI005-110714

Taylor, W.A., P.A. Lindsey, H. Davies-Mostert, 2015. An assessment of the economic, social and conservation value of the wildlife ranching industry and its potential to support the green economy in South Africa. The Endangered Wildlife Trust, Johannesburg.

Tembo, S, B.P. Mulenga, N. Sitko, 2015. Cooking fuel choice in urban Zambia: implications on forest cover. Indaba Agricultural Policy Research Institute, Working Paper No. 94, March 2015.

Turpie, J., B. Warr, J. Carter Ingram, 2015. Benefits of forest ecosystems in Zambia and the role of REDD+ in a green economy transformation. United Nations Environment Programme.

Vinya, R., Syampungani, S., Kasumu, E.C., Monde, C. & Kasubika, R., 2011. Preliminary Study on the Drivers of Deforestation and Potential for REDD+ in Zambia. A consultancy report prepared for Forestry Department and FAO under the national UN-REDD+ Programme Ministry of Lands & Natural Resources. Lusaka, Zambia.

Zambia Chamber of Mines, 2017a. A Brighter Future Powering Zambia's Economy.

Zambia Chamber of Mines, 2017b. Website, available at: http://mines.org.zm/

Annex

Table 3. Cost-Benefit comparison of conventional and organic farming in Zambia

	Conventional	Transition			Regenerative		
	Maize	Maize	Pigeon Pea	Soya	Maize	Pigeon Pea	Soya
Input Cost							
Seed	500	250	200	750	250	0	350
Fertilizer	1600	400			0		0
Manure	0	400			200		
Labour							
Land Preparation	750	100	25	150	100		150
Weeding	1500	500		500	400		400
Harvesting	1000	500	300	750	600	300	750
Sub-Total Cost	5350	2150	525	2150	1550	300	1650
Total Cost	5350	4825			3500		
Yield (kg/ha)	3000	1500	500	750	2000	700	1125
Maize @85kg/bag	5100	2550			3400		
P.pea@k250 bag			2500			3500	
Soya@k300 bag				3750			5625
Gross Income	5100	8800			12525		
Profit	-250 (LOSS)	3975 (PROFIT)			9025 (PROFIT)		
Scaled to NW Cropland							
ZMW	-474082750	7,537,915,725			17,114,387,275		
USD	$(49,903,447)	$793,464,813			$1,801,514,450		

Source: Grassroots Trust, Zambia.

Table 4. Estimated potential revenue from wildlife game ranches (using SA number and NWP areas, not including National Parks).

Revenue Stream	Mean Revenue per ha ($ USD)	Potential Revenue ($ USD)	Potential Revenue - GMAs and Protected Forests ($ USD)
Live Sales	31	$2,992,635,819	$ 126,716,539
Trophy Hunting	14	$1,314,725,930	$ 55,669,159
Biltong Hunting	4	$363,183,959	$ 15,378,221

Culling - Meat Sales	3	$239,701,413	$ 10,149,626
Trophy hunting - Meat Sales	4	$377,711,317	$ 15,993,350
Total	55	$5,287,958,437	$ 223,906,895

Source: Taylor et al. 2015.