Large-Scale Mining in Madagascar: an interdisciplinary assessment of economic and social impacts at national, regional and local levels

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and ethics procedures and guidelines have been followed.

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ASM	Artisanal and Small-scale Mining
CARA	Centre d'Affaires de la Région d'Anosy or Business Centre of Anosy Region
CCSI	Columbia Center on Sustainable Investment
CSB	Centre de Santé de Base or Basic Health Care Centre
CSO	Civil Society Organisation
CSR	Corporate Social Responsibility
CSRM	Centre for Social and Responsible Mining
CRS	Catholic Relief Services
DiD	Difference in Difference
DHS	Demographic and Health Survey (USAID)
DRC	Democratic Republic of Congo
EITI	Extractive Industries Transparency Initiative
EPM	Enquête Périodique auprès des ménages or Periodic Household Survey
FDI	Foreign Direct Investment
ICMM	International Council for Minerals and Metals
INGO	International Non-Governmental Organisation
INSTAT	Institut National de la Statistique (Madagascar) or National Statistics Institute
HDI	Human Development Index
HI	High Income country
LMI	Low- and Middle-Income country (World Bank classification)
LMIA	Large Mining Investment Act
LSM	Large-Scale Mining
MGA	Malagasy Ariary (national currency)
MIS	Malaria Indicator Survey
MPI	Multidimensional Poverty Index (UNDP)
MICS	Multiple Indicator Cluster Survey (UNICEF)
NGO	Non-Government Organisation
OLS	Ordinary Least Square
ONE	Office National de l'Environnement
OSCIE	Plateforme des Organisations de la Société Civile sur les Industries Extractives or Platform of Civil Society Organisations on Extractive Industries
PCD	Plan Communal de Développement or Town Development Plan

PIC	Pôle Integré de Croissance or Integrated Growth Pole
PNG	Papua New Guinea
QMM	QIT Madagascar Minerals (Rio Tinto)
SAP	Structural Adjustment Programs
SDG	Sustainable Development Goals
SME	Subject Matter Expert
UNCTAD	United Nations Conference on Trade and Development
WASH	Water, Sanitation and Hygiene
WEF	World Economic Forum

Abstract

Madagascar has colossal mineral deposits but is also one of the poorest countries in the world. After more than 15 years of Large-Scale Mining (LSM) operations, the country is at a turning point, with its current mining projects being scaled up and its new classification as a “resource-rich” country. Evidence suggests that having mineral resources can either be a blessing or a curse to a country and its people. The findings from the literature on the impacts of LSM in Madagascar also contribute to this empirical contradiction. The assessment of the effects of LSM has been highly contentious. On the one hand, the future benefits of such mining projects are promoted mostly using macro data. On the other hand, some scholars and Non-Governmental Organisations have shown how the impacts from LSM have been devastating economically, socially and environmentally using case studies and non-representative samples of data. The novelty of this study is to address the need for an objective assessment of the impacts of LSM in Madagascar by using an interdisciplinary approach and a mixed-method research design in addition to a comparison of impacts at the national, regional, and local levels. The econometric analysis of secondary data is combined with the analysis of new primary data from 730 individual surveys and 83 interviews of key mining stakeholders. The analysis performed at the national level confirms that Madagascar has its own trajectory in regard to mining and development, which differs from most of its sub-Saharan African mining neighbour countries. Also, overall Madagascar lags behind in terms of GDP per capita, GDP growth and HDI. More precisely, socially, LSM is negatively associated with Madgascar’s Human Development Index but interviews conducted reveal positive outcomes not captured. Economically, the results are inconclusive at this early stage of the country’s mining industry. At the regional level, the analysis shows that the livelihoods of those in mining

districts have worsened compared to those in neighbouring mining districts. This positive outcome for neighbouring mining districts results from less disruption of productive activities, as well as access to some of the large infrastructures built such as ports and roads; whilst mining districts have experienced a sharp rise in inflation due to the mining boom and a pull effect on the most deprived migrants. With limited assets owned and education, these migrants tend to struggle to fend for themselves and lower the overall wealth index of mining districts. Yet, within mining districts, those who live close to a mine (up to 20 km) have benefited more compared to those who live further away (up to 60 km) for whom most outcomes have dropped since the start of mining operations (wealth index, asset ownership, WASH). Within this 20 km-radius to the mines, at local level, working in mining leads to better outcomes, without generating social exclusion of workers at this stage. Near Ambatovy, since the level of poverty was lower, fewer households were directly affected by the mining operations and the investment was much larger, as expected these communities have experienced greater outcomes than those near Rio Tinto's QIT Madagascar Minerals mine. Most surprisingly, those who are the closest to the mine (0–10 km) are not those who benefit the most but rather those in a 11–15 km radius because of the impact on land, limited access to natural resources, pollution and the overall scale of disruption. These findings offer a diagnosis on the impacts of LSM in Madagascar, but most importantly provide insights into how investments by LSM companies in Low-and-Middle-Income countries could enhance the benefits and mitigate the negative effects on a range of socio-economic impacts depending on where people live. This thesis contributes to the growing literature on the resource curse with nuanced and comprehensive findings in order to inform more efficient, targeted and actionable strategies to leverage mining for sustainable development.

Chapter 1: Introduction and research design

There are very few industries that polarise and mobilise as much as the mining industry. At least two opposite conceptions are confronted: those who think that Large-Scale Mining (LSM) is *"by essence unfair with these foreign-owned companies extracting minerals that belong to poor countries"*[1] and those who consider that *"large mines are an opportunity for a developing country […] but we're not a charity, we're a business and we need to answer to our shareholders".*[2]

Voices in the middle are very few but the trend keeps growing. If modern life cannot be sustained without mining (Jacka 2018), how can we ensure that mining actually benefits mining countries? This thesis aims to provide some answers to this fundamental question by studying more precisely the impacts of LSM in Low and Middle Income (LMI) countries with a case study of Madagascar.

1.1 Background

1.1.1 Brief history of Large-Scale Mining (LSM) in Low and Middle Income (LMI) countries

LSM, described as capital-intensive mining and requiring large equipment as opposed to Artisanal-Scale Mining (ASM), has experienced a sharp rise for the past 50 years (IFC 2015, MacMahon & Moreira 2014). The increased need for mineral commodities in infrastructure, manufacturing and technology has fuelled this growth. "*Mining has the potential to contribute significantly to economic growth and to help lift millions of people out of poverty"* (IFC 2015, p. 4). Yet, overall, the industry suffers from negative

1 Interview of the head of a CSO in Madagascar.
2 Interview of a mining employee.

perceptions (Land & Tolonen 2017). This is mainly caused by the fact that most LSM companies are foreign-owned and viewed as a continuity of colonialisation, exploiting the riches of often poorer countries for their prime benefit. In sub-Saharan Africa, some of the largest mining companies by revenue are Anglogold Ashanti, BHP Billiton, De Beers and Rio Tinto (MiningAfrica 2021).

The theory of the “resource curse” popularised in the 1980s and 1990s by Gelb (1988), Sachs and Warner (1995) and Auty (1997) has contributed to this negative image, in addition to human rights violations, land grabs or large-scale pollution made public by activists, advocates and Civil Society Organisations (CSOs). Under the pressure of the latter and other stakeholders, LSM companies have had to adopt safeguards, code of conducts, best practices and overall become more accountable (Handelsmann 2002, Wachenfeld and Sturman 2018, Wall and Pelon 2011), even beyond their Corporate Social Responsibility (CSR) commitments (Ventura and Saenz 2015). The mining industry in Madgascar has also garnered mixed views over the past 15 years.

1.1.2. Overview of the LSM industry in Madagascar

Yet, the evidence on the economic and social impacts of LSM in Madagascar remains scarce, mainly due to the fact that its mining industry is recent compared to other mining-rich countries. ASM has been a widespread activity since the 17th century, however LSM only started more recently with the construction in 2005 of the QMM Rio Tinto ilmenite mine near Fort Dauphin and in 2007 the nickel cobalt Ambatovy mine near Moramanga (Ramdoo & Randrianarisoa 2016). They are respectively run by the Anglo-Australian mining company Rio Tinto and by a consortium of international mining companies (Sherritt International, Sumitomo Corporation and Korea Resources Corporation). Both mines are the largest out of the six in operation in

Madagascar as presented on Map 1, as of July 2019 corresponding to the end of the thesis fieldwork.

Map 1: Large-scale mines in Madagascar

More generally, in *"the new Eldorado for mining companies"* (Friends of the Earth 2012) are extracted a large variety of minerals and metals such as chromium, cobalt, ilmenite and nickel. The country also has gold, precious and semi-precious stones and oil reserves. In 2003, the World Bank stated that the main obstacle to foreign investment in the sector was due to the lack of knowledge of the country's mineral wealth (World Bank 2003).

1.1.3 About Madagascar: key characteristics and milestones

Madagascar, also called the “Great Red Island” (ESA 2009) given its size and the reddish tint of its bare earth, is one of the poorest countries in the world with a 2019 Human Development Index (HDI) ranking of 162 out of 189 (UNDP 2019). 73.3% of its population live with less than USD1.90 per day (World Bank 2020) and nearly one child in two under the age of five suffers from stunting (UNDP 2020). This country of 25.7 million inhabitants (INSTAT 2021) lies in the Indian Ocean off the coast of Mozambique. It is the only country in the world whose GDP per capita has decreased (by 40%) since becoming independent in 1960 without experiencing violent wars or conflicts (Razafindrakoto, Roubaud & Wachsberger 2020). GDP per capita stands at USD500.4 (Stocker et al. 2019). The country experiences recurrent fatal plague epidemics and natural disasters, as well as political crises which contribute to make it one of the poorest countries in the world as shown in Figure 1. The most recent political crisis started in 2008 when President Ravalomanana was ousted and a Temporary Authority led by President Rajoelina was in place from 2009 to January 2014. Yet, most international donors cut their aid funding during this period and international trade also dropped (Razafindrakoto, Roubaud & Wachsberger 2020). Madagascar’s economy mainly relies on exports of primary goods (e.g., vanilla, nickel, cobalt) according to the 2020 IMF Staff report (2020). Furthermore, over 90% of its workforce are working informally (INSTAT2013a).

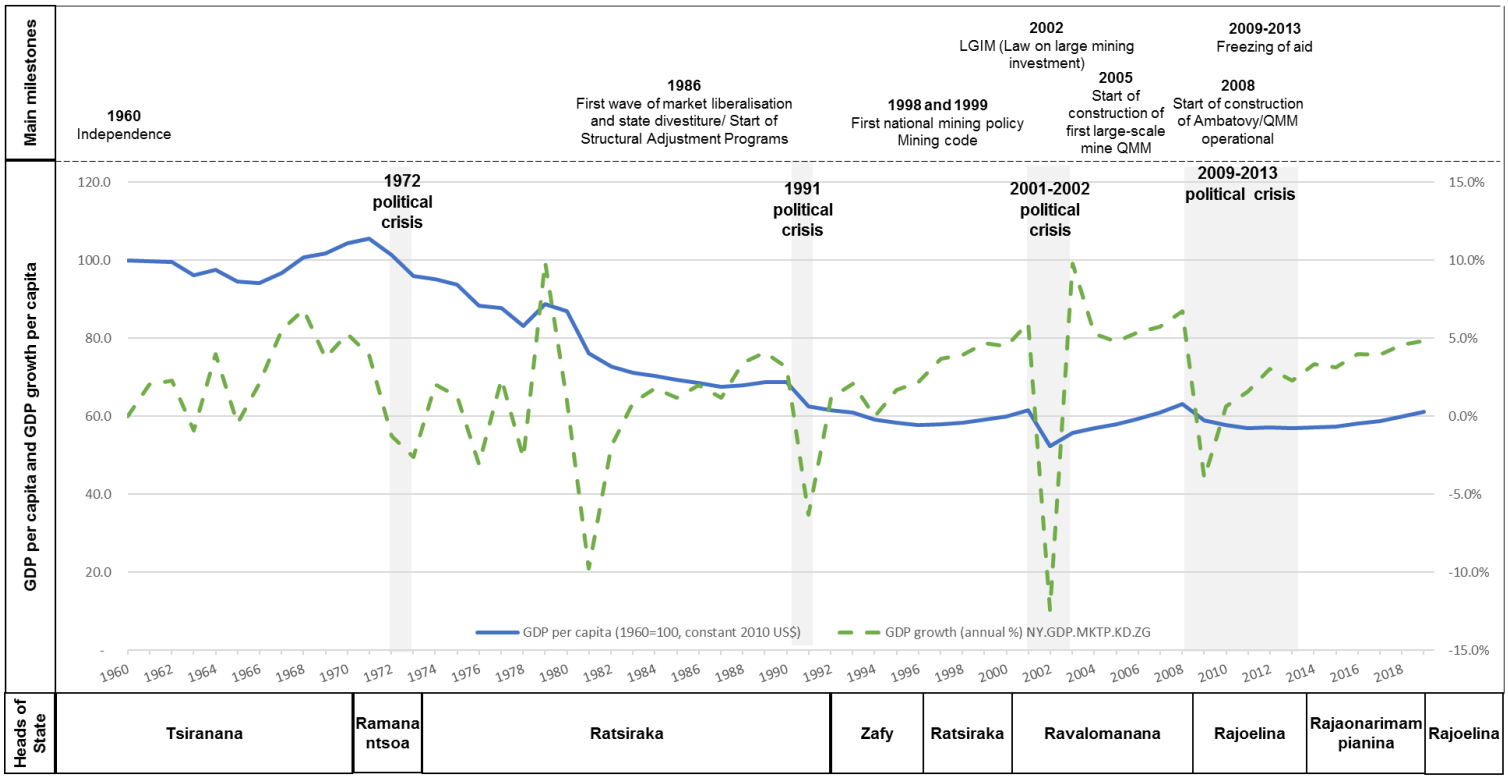


Figure 1: GDP per capita decline, socio-political crises and key mining-related milestones

Source: Author's calculations adapted from Razafindrakoto, Roubaud & Wachsberger (2020), data from World Bank Indicators

1.1.4 Rationale for this PhD

The rationale for studying the impacts of LSM in Madagascar can be broken down into three main reasons. First, LSM has ben considered as a strategic focus by Malagasy governments to drive its development (Ministère de l'économie et de la planification 2015). Given the emphasis that has been placed on LSM, it is imperative to understand the contribution of LSM in the development process. Second, unlike ASM, LSM is a formal activity and data is accessible making it relatively easier to study. In addition, ASM has been a widespread activity for centuries (Chambre des Mines 2014). Therefore, analysing the impacts of a more recent industry enables the use of a more

rigorous methodology assessing counterfactual scenarios. Third, in both the LSM industry and academic fields, Madagascar stands out, which justifies the idea of adopting a tailored methodological and pragmatic approach. Despite its *"colossal resources"* (Chambre des Mines 2014, p. 8) and in comparison to its sub-Saharan neighbours such as South Africa, Tanzania and Zimbabwe, it is a newly classified resource-rich country according to the IMF definition (Lundgren et al. 2013). Its exports of mineral resources represented at least 25% of its total exports for at least four years in a row since 2013 (IMF 2017).

Furthermore, scholars have found that classic economic or political economy theories do not apply to Madagascar (Razafindrakoto, Roubaud & Wachsberger 2020) to explain its economic and development trajectory. Since economic growth and development theories do not apply to Madagascar forming the *"Malagasy Mystery"* (Razafindrakoto, Roubaud & Wachsberger 2020, p. 15), it seems necessary to study the impacts of LSM on this country specifically before mining operations scale up even further.

Thus, after more than 15 years of large-scale mine operations, there is a strong rationale for undertaking this research so its findings can inform future policy development and enable the Malagasies to benefit from LSM activities as much as possible in a sustainable manner. Can LSM contribute to achieve Madagascar's sustainable development goals? What have been the economic and social impacts of more than 15 years of LSM? What could be improved to ensure more benefits for the country and its inhabitants?

1.2 Research aims and objectives

This thesis seeks to build on and complement the approach of the wide array of literature on the impacts of LSM in LMI countries. The novelty of this study is that it intends to add to the existing body of assessments of LSM impacts by proposing an interdisciplinary approach using mixed methods, while combining analysis at country, regional and local levels in a case study of Madagascar. The three research questions are:

1. What have been the economic and social impacts of industrial mining at country-level in Madagascar in comparison to other sub-Saharan mining countries?
2. What have been the economic and social impacts of industrial mining in mining regions in comparison to non-mining regions in Madagascar?
3. What have been the economic and social impacts of industrial mining on households and individuals in mining communities in comparison to those in non-mining communities?

The impacts at local level are studied using data collected in the vicinity of both of the largest mines currently in operation, QMM and Ambatovy. The most adequate paradigm or approach to conduct this research is “pragmatism” since it puts an emphasis on a combination of methods and a mix of quantitative and qualitative approaches in order to identify practical solutions (Morgan 2007). Pragmatics *“recognise that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture and that there may be multiple realities”* (Saunders, Lewis & Thornhill 2019, p. 151). Therefore, this study brings together theories from different disciplines such as development

economics, political economy and social sciences. It also provides an opportunity to test whether more nuanced results can be obtained with this research design.

1.3 Methods and methodology

1.3.1 Methods

As further discussed in the systematic literature review section (Chapter 2), most studies exploring the impacts of LSM use secondary data. When primary data is collected, it is mostly qualitative or in some instances quantitative but at a small-scale and with a non-representative sample. As the aim of the study is to develop a comprehensive and objective understanding of the economic and social impacts of LSM in Madagascar for the past 15 years, a mixed-methods design with relatively large samples seems to be the most appropriate approach.

The analysis of quantitative data enables objective findings while the qualitative data complement and qualify these findings. Both primary and secondary data are used for triangulation. The justification for the choice of methods in this study is aligned with the rationales for mixed methods formulated by Bryman (2006) and more specifically, credibility, utility, context, illustration and diversity of views. The aim of the qualitative interviews is to add depth to the understanding of the mechanisms at play described by the quantative part, not to analyse them in a statistical manner.

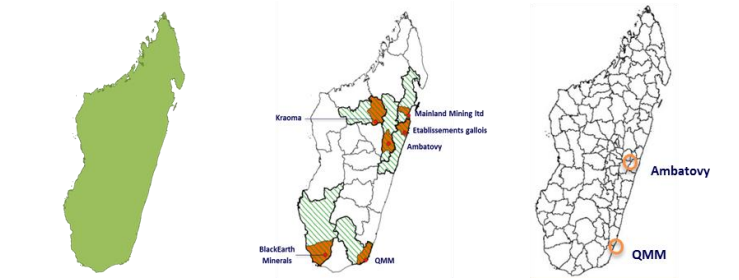
This mixed-methods design was implemented at multiple levels and in parallel. Both quantitative and qualitative research were conducted simultaneously and integrated to answer related aspects of the same research question or related questions. The fieldwork started by collecting secondary data at the country level which informed the regional and local level primary data collection. Moreover, the findings at the local level also led to more tailored interviews at regional and country levels. This approach is

supported by the International Council on Mining and Minerals (ICMM). It is detailed in the *Resources Endowment Toolkit* (ICMM 2008).

1.3.2 Methodology

Administrative subdivisions

The three research questions are aligned with the administrative subdivisions of the country. Madagascar is divided into 22 regions[3]. Those regions are the first-level administrative divisions. Each region is subdivided into districts, of which there are a total of 114. The districts are the second-level administrative divisions. Each district is divided into communes (total of 1,579) and each commune into *fokontanys* (total of 17,485). Figure 2 summarises the methods and methodology for each of levels of analysis.



Methodology/level	Macro (country)	Meso (regions and districts)	Micro (individual/ households)
Summary statistics	Secondary data		Secondary data
Econometric analysis			Primary survey data
Thematic analysis	Semi-structured interviews		

Figure 2: Summary of the methods and methodology for each of the three research questions

[3] A 23rd region was created in August 2021 but this has no impact on the results presented in this thesis.

Primary qualitative data: semi-structured interviews (RQ1, RQ2, RQ3)

Semi-structured interviews were conducted with stakeholders at country (RQ1), regional (RQ2) and local (RQ3) levels. The interviews had three sections:

- **Section 1:** The core section with the presentation of the study, introductory questions about their backgrounds and experience and questions addressing their views on how LSM projects may have impacted the country
- **Section 2:** Tailored questions specific to interviewees' roles.
- **Section 3:** A section with a couple of questions informed by the preliminary findings of the secondary data analysis or previous semi-structured interviews conducted. These questions were added on a need basis during the data collection process.

The core section of the questionnaires was tested on four interviewees from the mining industry, government officials, international donors and INGOs. Based on the result of the testing, the questionnaires were refined and finalised.

More precisely, the questionnaires explored (1) the impacts of LSM in Madagascar from 2005 to 2019[4] relative to its peer sub-saharan African mining countries with a focus on economic and human development perspectives; (2) the specificities of the Malagasy context (political, economic and historical) that can explain these differences; and finally (3) the recent or future undertakings to maximise the benefits of LSM (mining legislation, employment, project funded by Non-Governmental Organisations, World Bank, CSR).

Interviewees were recruited according to a quota sampling strategy that was completed by a "snowball" method until saturation was reached. The quota sampling ensured that each type of stakeholder is represented in the sample. A "chain referral"

[4] 2005 marking the start of the construction of QMM and 2019 the year of the fieldwork.

approach was also used to find and recruit additional participants. The main selection criterion for the participants were the roles they hold or have held as a mining stakeholder for at least 10 years. The categories of stakeholders are in line with what Sarrasin applied in his research (2006a) and what the ICMM recommends in its *Resources Endowment Toolkit: Assessment of Economic and Social Impacts of Large-Scale Mining* (2008).

Interviewees were contacted by email with a brief description of the project, the questions, an informed consent form and a plain language statement. The follow-up was done by telephone and email. For those who didn't have regular access to internet, a spontaneous visit was undertaken to inform about the study, run the interview on the spot or schedule a suitable timeslot later. The details of the contact logs were saved in a protected Excel spreadsheet. Most interviews (80 out of 83) were done face to face. The remaining three were conducted over the phone.

None of the interviews was recorded to respect the privacy of the interviewees. At the start of the interview, the interviewer asked the interviewee if they had read the plain language statement and if not read it out loud to them. Then the informed consent form was read, and interviewees asked to sign or give their oral approval which equated to a signature. A copy of the plain language statement and informed consent was given to each participant. Table 1 presents a breakdown of interviews per category of stakeholder.

Table 1: Overview of the semi-structured interviews conducted

Stakeholder type	Interviews
Public sector officials whose role is related to mining activities	8
Representatives of population and health	7
Representatives of regional/local authorities	23
LSM employees	12
Subject matter experts	14
Key stakeholders of the extractive industry	5
International donors with funding commitments to mining-related projects in Madagascar	1
CSOs and NGOs	9
Suppliers to LSM industries	4
TOTAL	**83**

Interview data were uploaded onto NVivo 12, as well as a table with the key characteristics of each interview to enable the classification of the interviews by level of analysis (macro, meso, micro), type of mining stakeholders and mine (Ambatovy or QMM if relevant). Then, the thematic analysis was performed.

The thematic analysis was conducted in three phases:

- **Phase 1:** classification of interview data by type and nature of impacts, leading to the creation of four nodes (positive economic impacts, positive social impacts, negative economic impacts, negative social impacts).
- **Phase 2:** classification of interview data by theme, leading to the creation of 27 nodes, such as mining revenues, mining code, mining operations, procurement, role of mining companies, policy recommendations. The large number of thematic nodes simplified the data classification process.
- **Phase 3:** re-grouping of nodes by key topics to identify the major findings of the interviews and structure the write-up process.

The findings of the interviews are presented throughout chapter 3 to 6.

Secondary quantitative data: Summary statistics and econometric analysis

As specified in Figure 2, secondary data are used to answer all three research questions. These data were carefully selected, using the most reliable sources available (e.g. World Bank, UNCTAD, UNDP, EITI, INSTAT the national institute of statistics). Furthermore, to address RQ1 and RQ2, econometric models are estimated using this data. The time periods vary for each research question. At national level, since the aim is to study the evolution of the impacts of LSM, the period studied runs from 1990 to 2019; whilst at regional level the focus is on exploring the differences between “before” (2008) and “after” LSM (2016 due to data availability).

Primary quantitative data: Econometric analysis

As for RQ3 at local level, the surveys were collected in 2019 with inhabitants living in the area for at least 13 years (10 years in the area near Ambatovy), including 3 years before the start of the mine operations. 730 household surveys specifically designed to capture the changes due to the large-scale mines on local communities in the vicinity of Ambatovy and QMM were collected.

1.4 Thesis outline and contributions

There have been only a few examples of development and growth historically spurred by LSM in countries like Australia, Canada or the US. By and large, LMI mining countries seem to have had a different fate. Yet, demand in these finite natural resources will keep on growing. The demographic boom in LMI countries combined with an increased reliance on technological products and efforts to reach a low-carbon future will keep on fuelling the demand for minerals and metals. According to the World Bank (2017), demand will be heightened more specifically for aluminium, copper, lead,

lithium, manganese, nickel, silver, steel and zinc. For some metals, there could be a two- to six-fold global increase in demand by the end of the century (Watari, Nansai & Nakajima 2021). This continuous increase in demand is occurring concurrently to uncertainty on the evolution of aid allocation to LMI countries (Bulíř & Hamann 2003, Kumi, Ibrahim & Yeboah 2017), despite their rising needs. In order for LMI mining countries to finance their development sustainably and independently, it is essential for them to be able to maximise the benefits of LSM and minimise its negative impacts.

The case study of this thesis is Madagascar, as its mining industry is comparatively recent but more permits are pending[5]. It is one of the poorest countries in the world, and the literature on this topic is quite scarce, and mainly focused on environmental impacts rather than economic and social. Thus, the contributions of this thesis are four-fold. First, it provides a comprehensive assessment of the impacts of LSM in Madagascar that had not been done at this scale before using large secondary datasets, 730 household and individual surveys and 83 semi-structured interviews. Second, it tests a research design enabling to reach more objective, nuanced and valid findings. Reliable and objective evidence is essential for all stakeholders to rectify and improve their strategies and practices. One on the novelties about this study is that it intends to add to the existing body of assessments of LSM impacts by proposing an interdisciplinary approach using mixed methods, while combining analysis at country, regional and local levels. Thirdly, this evidence can inform government policies at national, regional and local levels, but also CSO and NGO advocacy and program work, and mining company policies on how to support Madagascar and its inhabitants to benefit more from mining operations. Tailored initiatives could be

[5] 21 were pending according to the Chambres des Mines in 2013 and since the permit grant has been frozen but could start again.

developed using these findings depending on where people live (within 20 km to a mine, within a mining district or beyond) and what they've been affected by (e.g. loss of revenues, health, WASH-related). Finally, we show that the larger the investment and the smallest the disruption of local communities, the better it is for households. The socio-economic characteristics of the area of operation pre-mining also matter. Future investments in Madagascar and more generally in Low-and-Middle-Income countries should take this into account, especially when planning to invest in poverty-stricken areas.

This thesis is divided into six chapters. Chapter 2 presents a systematic analysis of the literature on the impacts of LSM in LMI mining countries. The debate on the economic and social impacts of the extractive industry is *"contentious and ambiguous"* (Bebbington et al. 2008). There is no consensus on whether extractive wealth is a blessing or a curse for LMI countries. It has been profusely contested over the past decades. Nevertheless, most literature reviews on the topic include articles with findings combining fuel and non-fuel producing countries, High Income (HI) and Low and Middle Income (LMI) countries and focus on a specific discipline. This chapter contributes to the existing literature by analysing 107 studies examining the impacts of non-fuel mining in LMI countries only across a wide range of disciplines. It also offers a perspective on the evolution of dominant trends in the literature since 1970, and most importantly on the conditions to enhance positive outcomes and mitigate negative ones.

Two of the main contributions of chapters 3, 4 and 5 to the existing literature is that they combine findings from quantitative and qualitative data to provide more objective and accurate insights, and they explore economic and social impacts of LSM at each level respectively (i.e., national, regional and local). Thus, Chapter 3 is concerned with

the impacts of LSM at national level using macro indicators such as mining rents, GDP per capita and the Human Development Index (HDI) from 1990 to 2019. This chapter also contributes to the literature by exploring the relationship over time between key macro aggregates and LSM using mining rents rather than mining dependence or mining abundance. The latter are often respectively proxied in some of the most notorious studies on the topic by mining share in exports and mining production or asset reserves (Auty 1993, Brunnschweiler & Bulte 2009, Collier 2000, Sachs & Warner 1995, Ross 2001). Furthermore, this chapter offers a comparison between the impacts of LSM in Madagascar with other sub-saharan African mining countries such as Angola, Ghana, Mali, South Africa and Zimbabwe.

Chapter 4 investigates the economic and social impacts of LSM but this time at a regional level and relative to non-mining regions. It contributes to the literature by applying the Difference-in-Difference (DiD) econometric approach used by Chuhan-Pole, Dabalen and Land (2017) around six mines. It compares outcomes of mining and non-mining districts, mining districts and neighbouring districts, and finally by distance using concentric bins from 20 to 60 km from the mines. This innovative analysis is done using Demographic and Health Survey (DHS) and Malaria Indicator Survey (MIS).

Chapter 5 examines the effects of the arrival of two mines (QMM and Ambatovy) on the communities living in their immediate vicinity (0 to 20 km). It contributes to the literature by using a relatively large dataset of unique primary data with 730 household and individual surveys. It enables to measure the impacts of both mines on a wide range of economic and social indicators for these communities over the past 15 years such as employment, income, spending, health, access to natural resources, community trust and violence. In addition, its contribution is to provide a detailed

assessment of communities' experiences depending on how close they live from the mines (i.e., 0 to 10 km, 11 to 15 km, 16 to 20 km), which had not been done at this scale and with this degree of precision before.

Finally, Chapter 6 concludes by summarising the main findings of this research, as well as discussing policy recommendations augmented with suggestions made by interview participants. This chapter also outlines the limitations of this thesis and provides suggestions for further research.

Chapter 2: Systematic literature review of the economic and social impacts of Large-Scale Mining in Low- and -Middle Income countries

> *"Contentious and ambiguous: two words which describe the relationship between large-scale mining and development. 'Contentious' because mining has so often delivered adverse social, environmental and economic effects for the many, but significant gains only for the few; 'ambiguous' because of the abiding sense, among local populations as much as development professionals, that just maybe mining could contribute much more."* (Bebbington et al. 2008 p. 887)

2.1 Introduction

The impacts of Large-Scale Mining (LSM) in Low and Middle-Income (LMI) countries remain an *"ambiguous and controversial"* matter (Bebbington et al. 2008). LSM is distinct from artisanal and small-scale mining (ASM). The former is capital intensive and is usually undertaken by multinational corporations. The latter is usually undertaken by individuals working independently or in small groups, is labour intensive and often done by hand. On one side of the debate, LSM has been promoted as an important driver of economic growth and improvements in human wellbeing. It is argued that, by exploiting available extractive resources, LSM raises economic growth by creating opportunities for domestic employment, increasing local demand and investment, and generating public revenues that can be used for the provision of basic services.

On the other side of the debate, it is argued that most mineral-dependent nations have remained in a state of impoverishment, characterised by high levels of income inequality and poverty (Dobbs et al. 2013). Many mineral-dependent countries have some of the lowest HDI scores (Hilson & Haselip 2004). This represents a resource 'curse' arising from rent-seeking behaviour and significant negative environmental and social externalities that outweigh any benefits. Thus, as it stands, whether LSM is a blessing or a curse in LMI countries is still highly contested.

Recent reviews of the literature from Badeeb, Lean and Clark (2017), Cust and Poelhekke (2015), Deacon (2011), Papyrakis (2017) and Van der Ploeg and Poelhekke (2017) provide important insights into the impact of mining. This thesis seeks to build on and complement the approach of these reviews. First, it undertakes a systematic review of both the economic and social impacts and does not restrict its scope to studies from a particular disciplinary background. Second, it confines its review to impacts of non-fuel minerals in LMI countries. Existing reviews combining insights from the extraction of fossil fuels (oil, coal and gas) and non-fuel minerals (e.g., nickel, titanium, copper) in both LMI and developed countries can mask important differences in impacts (Weber-Fahr 2002). Third, this review uses the proliferation of studies since 1960 and provides a nuanced perspective on mining impacts and the conditions under which LSM can spur development.

Gaining a better understanding of the economic and social impacts of LSM is essential to mitigate negative outcomes while fostering and scaling-up positive ones in a world where *"contemporary global livelihoods depend almost completely on the extraction of mineral resources"* (Jacka 2018 p. 61).

In total, 107 documents published between 1970 and 2020 are included and analysed in this review. In sum, findings suggest that LSM can generate revenues, but issues arise with the volatility and collection of these revenues. Government expenditures increases with mining revenues although the impact of this additional spending on development appears limited. Impacts of LSM on economic growth are mixed. Mining abundance dependence remains negatively correlated with growth unless governance and types of minerals are accounted for. There is a consensus from the extensive literature that LSM is not a catalyst for human development and to mitigate negative outcomes governance must be strengthened and regulations need to be in place. Finally, to comprehensively assess the impacts of LSM it is argued that country, regional and local-level analyses need to be undertaken using quantitative and qualitative data and an interdisciplinary approach. This critical stance questioning the robustness of the most commonly used methodologies to examine the impacts of LSM echoes a broader trend among researchers.

The remainder of this chapter is structured as follows. Section 2.2 provides a summary of the methods used in undertaking the systematic review. Section 2.3 presents the findings from the review while Section 2.4 discusses the limitations of existing studies and concludes with some directions for future research. Unless otherwise noted, the term “mining” will be used in this thesis to solely refer to non-fuel minerals and metals including bauxite, chromite, copper, diamond, diamonds, gold, hard minerals, iron ore, nickel, phosphate platinum, silver, tin, titanium ore, uranium and zinc, among others.

2.2 Research methods

2.2.1 Study selection process

The methods adopted in this study are consistent with established systematic review protocols and best practices (see PRISMA 2020, Tranfield, Denyer & Smart 2003, Waddington et al. 2012). Our search protocol was executed in multidisciplinary bibliographic databases including Elsevier, Google Scholar, ProQuest and Science Direct. We also used development-specific databases such as the Joint Libraries of the World Bank and IMF (JOLIS) database and the ELDIS database (Institute of Development Studies) as well as other general databases including IDEAS/Repec, Econlit and the National Bureau of Economic Research (NBER). These databases ensured a comprehensive coverage of both academic and non-academic literature.

The keyword search was done in both English and French between March 2019 and September 2020. Using a combination of two to four keywords (from “Large-Scale Mining”, “extractives”, “mining”, “impacts”, “economic” and “social”) included in a title or abstract, our search yielded 973 results. Fifty-two additional records were found in the libraries of the African Development Bank, Asian Development Bank, and Inter-America Development Bank; 124 additional references were found using Mendeley. After removing duplicates, a total of 889 were screened. Following the full-text screening, 107 studies were selected for inclusion in this systematic review. Details of these studies are provided in Appendix 2.1. Studies were excluded based on the following criteria: unavailability of full-text (6), using data pre-1960 (6), examining ASM instead of LSM (20), not focusing on the economic or social impacts of mining (27), not focusing on LMI countries (65) and not examining just hard minerals extracted from the ground (including fuels or deep-sea mining) (81). Studies were also excluded if they did not have a research design (an explanation of methodology, sampling and

analysis strategies) (47) and (most commonly) if they did not undertake any empirical analysis (530). The emphasis put on the empirical contribution of studies is essential in this systematic review as it aims to reach objective conclusions rather than rely on subjective opinions. Including other literature reviews would have made it difficult to ascertain the weight given to each study reviewed.

It must be noted that the intent of each reference to study some economic and/or social impacts of mining as well as the thoroughness of their research endeavours prime over the strict comparability of data. Thus, the included studies include those taking quantitative and qualitative approaches, as well as examinations of individual or groups of countries across different time periods. These are essential conditions to be able to compare findings beyond disciplines and consider the literature as a whole body of work providing evidence to address the same fundamental questions about the impacts of LSM, albeit in different ways. Finally, this systematic review aims to be comprehensive but cannot claim to be exhaustive.

2.2.2 Main characteristics of the studies selected

The breakdown of the studies by journal and institution confirms the multidisciplinary intent of this systematic literature review. The detail of the breakdown can be found in Figure 3. Thirty-five of the studies selected come from the journals *Resources Policy*, *World Development* and *Journal of Cleaner Production*, and international organisations such as the World Bank and the International Council on Mining and Metals (ICMM), while 20 studies come from ten other journals and 52 from other single sources.

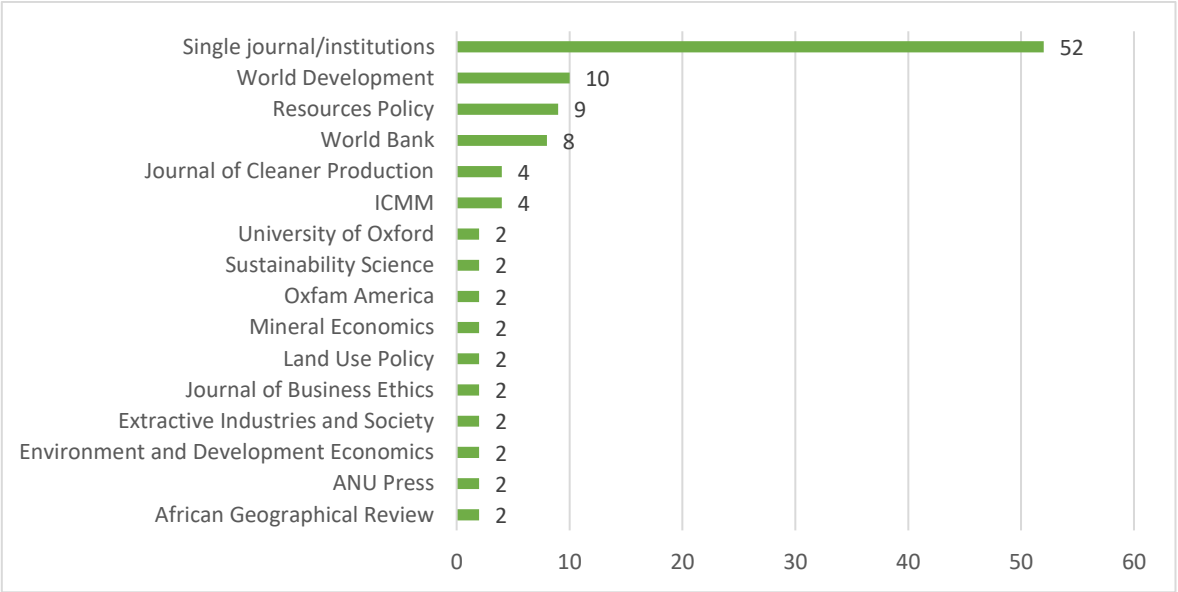


Figure 3: Breakdown of records by journal or institution name

Source: Author's calculations

The oldest study included in the review was published in 1971 with relatively few studies (38) published thereafter until 2010, when the number of studies published increased considerably (69). This followed the sharp growth in mining investments post the 2003 mining boom. Figure 4 presents the evolution of the number of studies published by year.

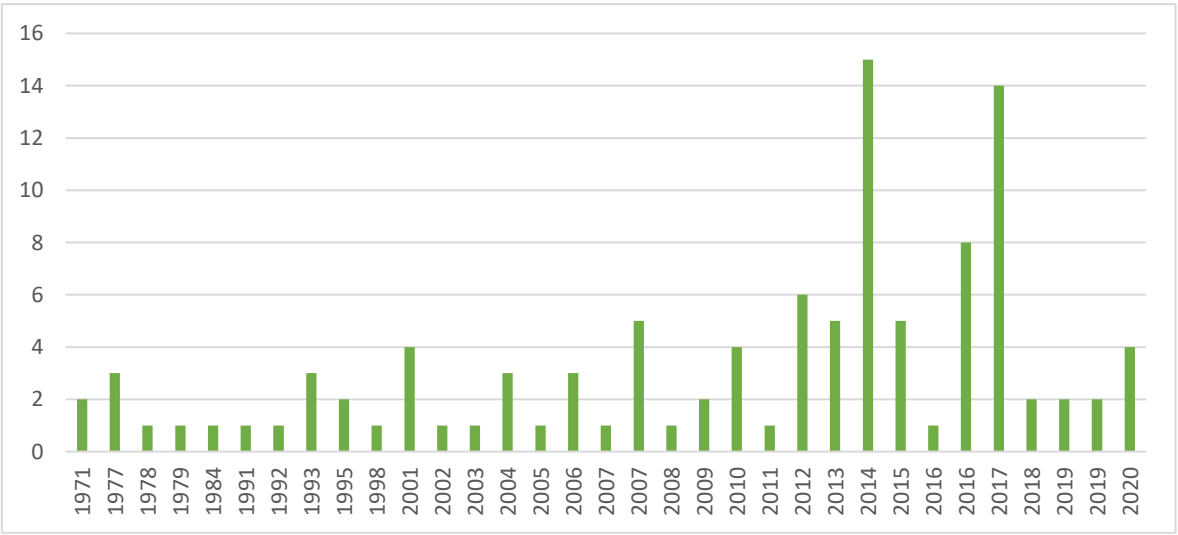


Figure 4: Evolution of the number of studies published by year, 1971–2020

Source: Author's calculations

Figure 5 presents an overview of the minerals studied. There are 15 different types of minerals included in “hard minerals”, with a combination of at least more than two individual minerals. A large proportion of studies focus on hard minerals (57%) and then gold (26%).

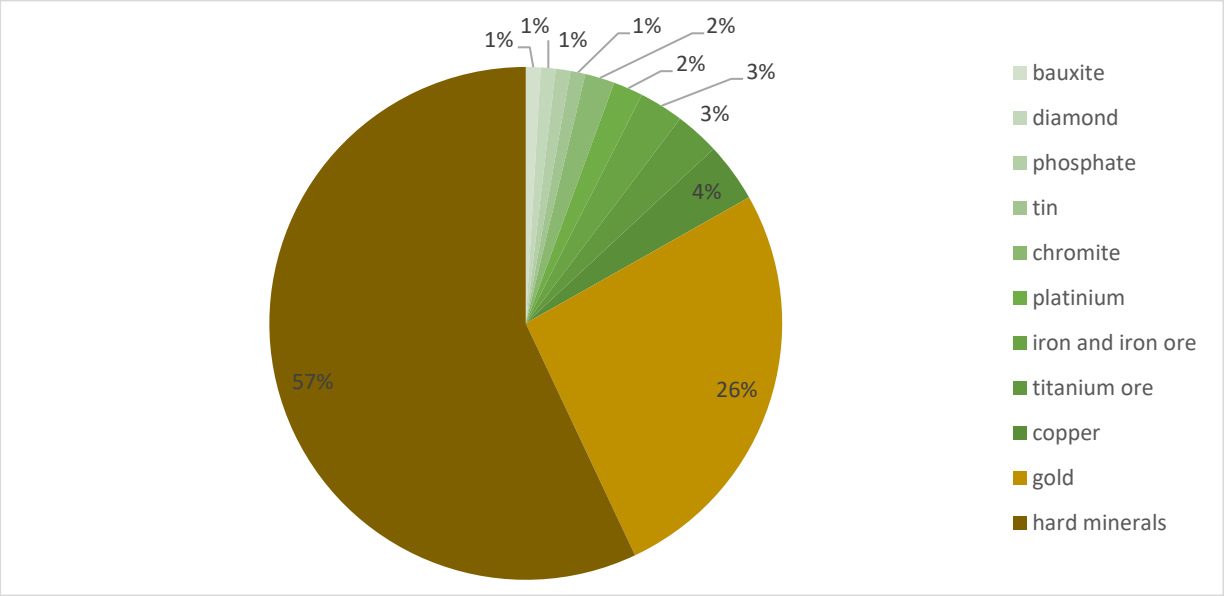


Figure 5: Breakdown of hard mineral studies selected

Source: Author’s calculations

2.2.3 Conceptual framework

The findings of this systematic literature review are organised according to a conceptual framework adapted from ICMM (ICMM 2016) and the work of Papyrakis and Gerlagh (2007). This simplified framework presented in Figure 6 illustrates the focus of this chapter on mining revenues, spending and investment transmission channels and their expected effects on human development and economic growth.

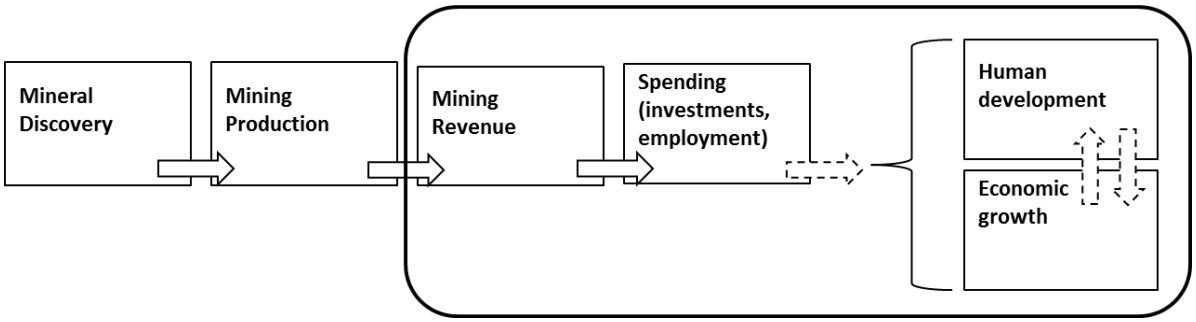


Figure 6: Channels of economic and social impacts of Large-Scale Mining

Source: Author, based on ICMM (2016 p. 30), Papyrakis and Gerlagh (2007)

2.3 Findings from the literature

This section begins by examining the evolution of views on mining. Then, it focuses on the evidence on the impacts of mining in generating revenues and domestic (government) spending. It proceeds by examining the impacts on economic growth and human development. Finally, it discusses the conditions that are necessary to mitigate negative outcomes from mining as well as those to foster positive impacts. The findings are organised in a chronological order with dates and countries concerned specified in the text.

2.3.1 Evolution of leading views and the resource curse

The evolution of the number of studies by type of view (positive, neutral/nuanced/non conclusive, and negative) presented in figures 7 and 8 follows the evolution of the theories on the natural resource curse (McMahon & Moreira 2014, p. 7). It is worth highlighting that most references written after Auty coined the term “resource curse” in 1993 position themselves in regard to this theory, whether they support challenge or nuance it. This resource curse illustrated in empirical studies such as Gelb (1988), Auty (1993) and Sachs and Warner (1995) showed that countries with abundant natural resources – especially non-renewables such as minerals and hydrocarbons – fared much more poorly in comparison to countries with no or less resources at similar

stages of development (Loayza & Rigolini 2016, McMahon & Moreira 2014). Gradually the view on the impacts of mining seems to have changed from negative to mixed and positive on economic impacts. As Ericsson and Löf (2019 p. 242) outlines, *"during the late 1900s until recently, the dependency approach was dominating claiming that abundance of mineral resources hinders economic development rather than facilitating it".* Then, *"the resource curse paradigm was another starting point for critical analysis".* Yet, *"this a priori negative starting point was beginning to be questioned during and after the 'super cycle' with high metal and oil prices".*

Sixty-four of the studies examine the impacts of mining in 17 LMI countries and 43 studies explore impacts in multiple countries. Ghana and Peru are by far the most studied (19 and 13 studies respectively). A larger number of studies highlight the negative impacts (63%) of LSM since 1971 rather than those highlighting its positive impacts (16%) or studies being more nuanced (22%) as shown in Figure 7.

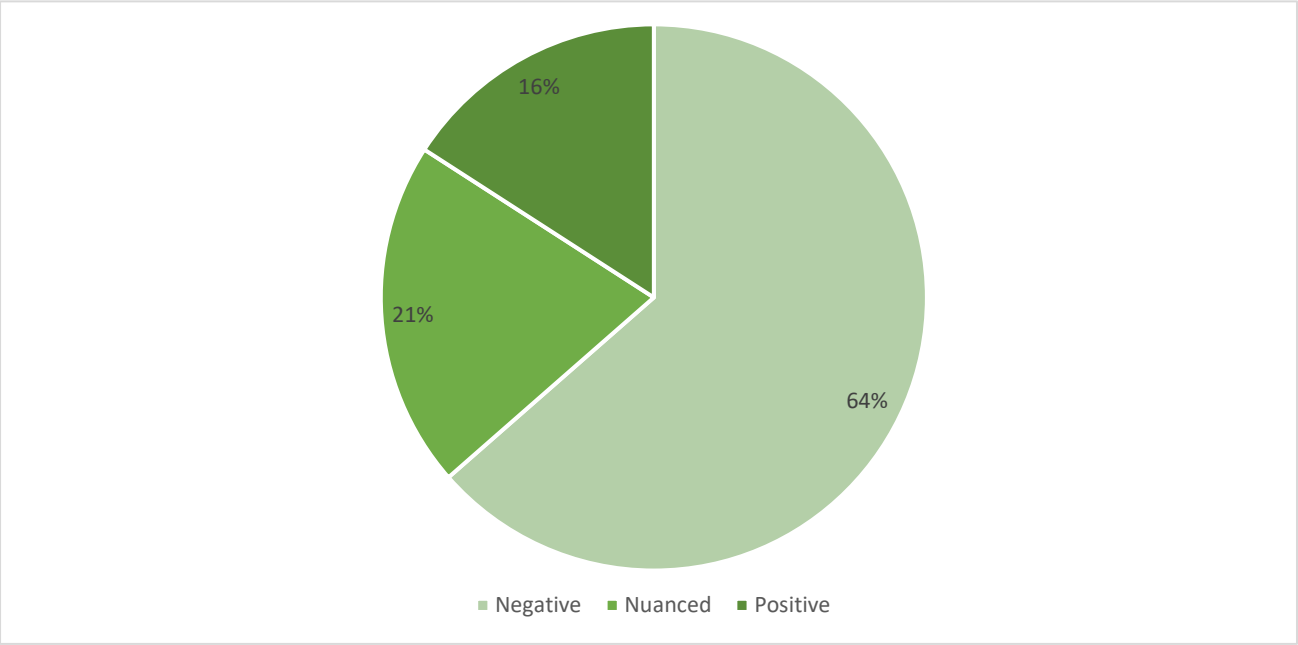


Figure 7: Proportion of studies per view since 1971

Source: Author's calculations

Yet, it must be noted that in recent years there has been a growing number of studies with more nuanced views, as highlighted in the three graphs of Figure 8.

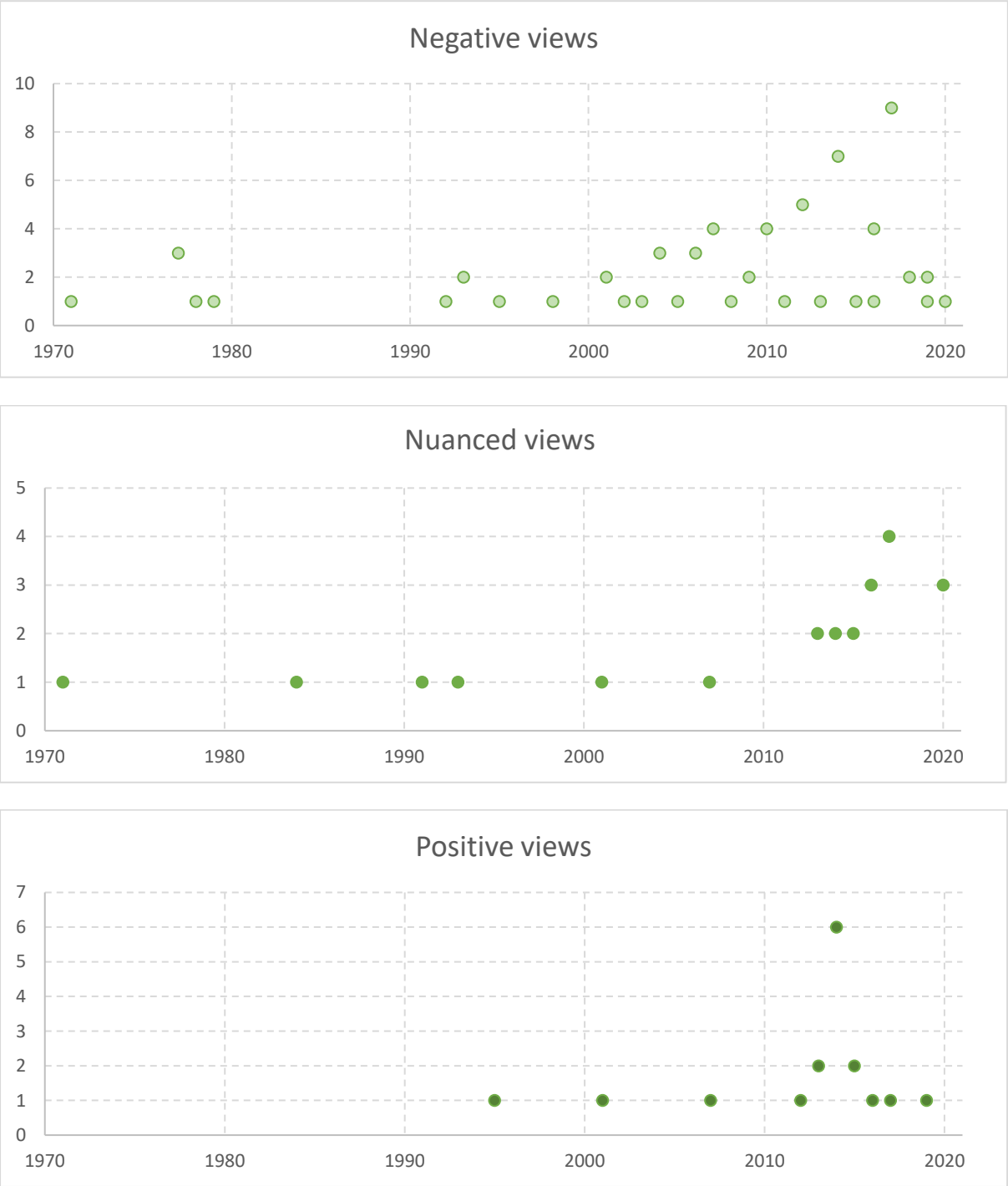


Figure 8: Evolution of the number of studies per views since 1971

Source: Author's calculations

As for the Dutch[6] disease, unlike for fuel-rich LMI countries, it is not identified as a major cause of development curse among the studies selected. Only one study (Auty 1993) outlines the detrimental impacts of the Dutch disease on mining LMI countries. One study focused on the negative social impacts is concerned with the *"political Dutch disease"* (De Soysa & Neumayer 2007). Two studies classified as "positive" towards mining (Aryee 2001, Davis 1995) challenge the fact that the Dutch disease affected Ghana or any of 22 other mineral LMI economies respectively.

In total, our sample comprises nearly 79 studies that explore the economic impacts of mining: 42 highlight the detrimental impacts of LSM on developing economies, 17 find positive effects of mining while the remaining 20 report findings that are nuanced (i.e., pointing to negative effects in some instances and positive effects in other instances). As for social impacts, unlike for the economic impacts of LSM, a strong consensus emerges on the detrimental social impacts of LSM. Out of the 69 studies concerned with the social impacts of LSM, only 12 (Davis 1995, Ericsson & Löf 2019, Fafchamps, Koelle & Shilpi 2015, Kotsadam & Tolonen 2016, Chuhan-Pole, Dabalen & Land 2017, Loayza & Rigolini 2016, Lippert 2014, McMahon & Moreira 2014, Ticci & Escobal 2015, Zambrano, Robles & Laos 2014) discuss positive social impacts. Table 2 presents the breakdown of studies selected by type of impact and view.

Table 2: Breakdown of studies selected by type of impact and view

Type of impacts	Number of Studies	Positive	Nuanced	Negative
Economic impacts	79(100%)	17 (22%)	20 (25%)	42 (53%)
Social impacts	69 (100%)	12 (17%)	0 (0%)	57 (83%)

[6] Whereby increases in commodity prices or high levels of mining investment appreciate the domestic currency which harms the competitiveness of other sectors in the economy.

Following the analysis of the characteristics of the studies included in this literature review, the next section provides their insights on whether LSM leads to revenue generation.

2.3.2 Does LSM generate higher revenues?

LSM generates revenue for LMI countries' governments in various forms: taxes on profits and income, mineral resource taxes and royalties, and other corporate taxes and fees (Otto et al. 2006, p. 255). The analysis of the literature demonstrates that these revenue streams are considered a key contribution to national economies but that they are highly volatile and often difficult to fully collect.

Mining revenues and the taxes paid by mining companies in the country where they operate are cited as major contributions to economies by nine studies. In Papua New Guinea (PNG), the Bougainville copper mine contributed the equivalent of 15 million USD to government revenues in 1980 (Quodling 1991). In South Africa, large-scale gold mining was considered as a major lever for industrial expansion in the 1970s. In 1972, 76.3% of the gross fixed capital investment in the country was funded by taxes. Mining taxes accounted for 43% of mining profits (Lageat 1978). With the mining boom and the growth of mining investments in the 2000s (McMahon & Moreira 2014) the proportion of mining revenues grew to represent between 12% and 37% of the GDPs of Botswana, DRC, Ghana, Guinea, Mauritania, Mozambique, Tanzania and Zambia (Bloch & Owusu 2012, ICMM 2015, Roe & Dodd 2016, Romo et al. 2014, UNDP 2014a). Mining taxes were reportedly low before the 2003 boom but increased sharply after for a select few countries. Mining taxes in Chile, Ghana and Peru reached between 17.5% and 19% of GDP during 2007 and 2011 (McMahon and Moreira 2014, p. 32, Zambrano, Robles & Laos 2014). In Peru, between 2005 and 2011, mining funds

allocated to the mining regions' subnational governments grew by more than 382%, or USD7.7 billion in total, making them the main source of public funding for subnational governments in mining regions (McMahon & Moreira 2014).

Most of the literature examining the impacts of mining acknowledge the volatility of mineral commodity prices regardless of whether they find positive, neutral or negative impacts (e.g., Addison, Boly & Mveyange 2017, Bridge 2004, Dauvin & Guerrero 2017, Ericcson & Löf 2017, Weber-Fahr 2002). Bridge (2004, p. 419) concludes that the investment boom in developing countries following the mining boom in the 1970s to the early 1990s was not a *"concomitant 'bonanza' in the global South"* but rather a targeted strategy to invest in specific LMI countries (i.e., Peru, Chile, PNG and South Africa) and concentrated on a few commodities (specifically copper and gold). In addition, Bridge (2004, p. 410) shows the volatility of these investments, linked to the volatility of commodity prices and *"the vagaries of the market for finance capital"* (p. 410). Following the mining boom, Foreign Direct Investment (FDI) in LMI mining countries fell dramatically and investments were channelled towards mature industries in "developed countries" and by doing so left LMI mining countries without substantial revenues to support their development.

Furthermore, even in studies promoting the benefits of LSM, there is a consensus that except in a few lucky countries, mining revenues are low compared to levels of FDI and exports. Most of the 72 studies examining the economic impacts of LSM support the view that there was room for improvement in terms of revenue collection for authorities at all levels of government. The literature suggests that constraints on revenue collection relate to corruption, lack of information, lack of capacity and a lack of appropriate mining legislation (Curtis and Lissu 2008, Lippert 2014, McMahon & Moreira 2014). More specifically, in Mali, interviews conducted with people living in

communities affected by LSM activities revealed that local authorities did not have the capacity to verify whether the amount of mining revenues they received were the amounts they were entitled to. Studies also outline the confusion between legally mandatory payments and funding for activities related to CSR,[7] which can also result in limiting the revenue collected from mining activities in LMI countries (Parker and Wood 2006).

In summary, some mining countries (Peru, Chile, Ghana, Botswana) fared better than others in terms of mining revenues collected depending on the size and maturity of their LSM industry, their mining codes and levels of governance and local capacity. Successful countries in this respect appear to be more of an exception than the rule. While LSM can generate revenues for governments, the level of revenues rarely matches initial announcements and expectations (Canavesio 2014, Imbun 2007, Smith 2014). Moreover, it is how additional revenue is mediated by the government which will determine the impact of mining on growth and development. This is the issue to which we now turn.

2.3.3 Does LSM foster spending domestically?

References on government spending are limited as most of the studies focus on companies' investment and spending, employment and spillovers. According to 23 studies, LSM does foster domestic spending even though there is room to scale it up.

LSM operations are capital-intensive and require large investments either to develop and equip mining sites directly or to develop surrounding infrastructure they will need

[7] Corporate social responsibility (CSR) is a management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders. CSR is generally understood as being the way through which a company achieves a balance of economic, environmental and social imperatives ("Triple-Bottom-Line-Approach"), while at the same time addressing the expectations of shareholders and stakeholders. In this sense it is important to draw a distinction between CSR, which can be a strategic business management concept, and charity, sponsorships or philanthropy (UNIDO 2021)

to operate. As noted in the introduction, most LSM is undertaken by multinational corporations and funded through FDI. This review reveals that there is a strong consensus on the importance of mining FDI. In PNG, the mining sector accounted for around two-thirds of all foreign investment between 1973 and 1990 (Banks 1993). Mining investment was by far the largest source of FDI in Chile, Peru, and South Africa between 2007 and 2011 (McMahon & Moreira 2014). In 2013, over 50% of FDI in Ghana was related to the mining sector (ICMM 2015).

Beyond direct investments to support their operations, LSM companies generate direct, indirect or induced employment (Cordes et al. 2016) according to 12 studies. *"Contrary to the notion that there are no jobs in mining, in this small sample, employment related to the mining sector was very high in countries where linkages were strong, even before the multiplier and fiscal expenditure impacts were accounted for"* (McMahon & Moreira 2014 p. v). Chachage et al. (1993) reported that in Zimbabwe, the formal sector mining industry employed between 50,000 and 60,000 workers in the 1970s. Despite the number of employees falling in the 1980s due to lower output and increased mechanisation, the industry is still comparatively labour intensive (Chachage et al. 1993). Other studies argue that in addition to employment gains, workers obtain higher wages from working in LSM (ICMM 2015, Maliganya 2017). In Ghana, mining companies were found to pay on average USD85,000 per job, with other (related) sectors also receiving higher than average wages (ICMM 2015). Furthermore, the country case studies of Ghana, Mali and Tanzania and the empirical results confirm that mines do succeed in raising incomes for those living in their vicinity (Chuhan-Pole, Dabalen & Land 2017).

At national level, mining typically accounts for 1% to 2.5% of total direct employment in a sample of 180 mining economies. However, accounting for the indirect jobs it

creates, mining could account for anywhere from 3% to 15% of total employment according to Roe and Dodd (2016). In terms of indirect and induced employment or the "employment multiplier", its value varies across countries but usually ranges between 1.67 and 5.00, although a much larger multiplier has been found in the case of Ghana with around 20 indirect and induced jobs per direct job in mining (Chuhan-Pole, Dabalen & Land 2017, Kapstein et al. 2010, Roe and Dodd 2016, Sanoh and Coulibaly 2015, Solomon 2012). Östensson (2014) found that in the case of Zambia, up to 43,800 jobs were created from spending from mining social programs, employees, contractors and goods and services suppliers of two copper and gold mines between 2012 and 2013. LSM often leads to the emergence of a nearby cluster of firms supplying and servicing mining operations and exploration. Clusters comprise four tiers: Tier 1, direct suppliers; Tier 2, indirect suppliers; Tier 3, direct mining services; and Tier 4, indirect services producers (Bloch and Owusu 2012).

Employment opportunities at higher than average wages foster domestic spending of goods and services. This effect is often referred to in the literature as "spillover" impacts. The benefits of mining operations were found to extend beyond the vicinity of mines in Ghana, Mali and Tanzania over the period 1989 to 2012[8] (Kotsadam and Tolonen 2016). Aragón and Rud (2013) study regional spillovers by analysing 7,700 households located in 101 districts in Peru. Their Difference-in-Difference (DiD) analysis confirm that backward linkages from extractive industries create positive spillovers through raising demand in surrounding areas. Further, *"in PNG, the economic impact of the Bougainville copper mine was assessed to be 'substantially more beneficial than the simple sum of direct payments"* (Quodling 1991 p. 37).

[8] Dates differ per country depending on availability. See Chuhan-Pole, Dabalen & Land 2017, p. 103.

At the same time, according to most reviewed studies, beyond a few lucky countries such as Chile, Ghana, Indonesia, Peru and South Africa (McMahon & Moreira 2014), mining impacts on incomes have been much lower than expected. Employment opportunities, in general, have been scarce. For LSM in PNG, direct employment accounted for only 4% of the formal sector labour force in 1983 despite minerals being the most important exports between 1973 and 1990 (Banks 1993). In Ghana, Roe and Samuel (2007) find that while output of gold, diamonds, bauxite and manganese rose during the period 1994 to 2004, employment in the formal mining sector actually declined. The study attributes this decline to mechanisation as well as to less labour-intensive extraction techniques such as open-pit mining. The preference for skilled expatriates has been cited as a reason for the low number of people locally employed in the case of South Africa (Curtis and Lissu 2008, Lageat 1978). Low demand for local workers has also been linked to low skill levels of the local population and limited training opportunities (Auty 2001a, Parker and Wood 2006), especially for multinational mining companies (Wegenast, Khanna & Schneider 2020). As a result, Bazilier and Girard (2020) and Pokorny et al. (2019) found that the opening of an industrial gold mine has no impact on local consumption, job opportunities and cash income for local households unlike for households near artisanal mines between 1998 and 2014 in Burkina Faso. Despite finding generally positive impacts from LSM a study concludes:

> *"it is fair to say that their backward linkages are not large. Multiplier effects are limited, partly because of the capital intensity of the mining industry, but mostly because of the lack of local cost-effective. procurement opportunities. The proportion of inputs sourced locally remains low, a*

situation mirrored in Ghana, Mali, and Tanzania." (Chuhan-Pole, Dabalen & Land 2017 p. 15)

Overall, LSM activities can foster higher incomes and spending through direct and indirect employment but also through governments and international donors but is impacts are limited in scale.

The Conceptual framework for the expected impacts of LSM demonstrates that increased revenues should lead to increased spending, which in turn should lead to economic growth and improved human development. The next sections are concerned with what the reviewed literature finds with respect to these outcomes.

2.3.4 Does LSM spur economic growth?

"We have here, in Africa, everything necessary to become a powerful, modern, industrialised continent … Africa, far from having inadequate resources, is probably better equipped for industrialisation than almost any other region in the world" stated Kwame Nkrumah, Ghana's first Prime Minister, in 1960 (Freeman 2014 p. 648). Whether this vision of natural resources and more specifically mining as an engine of growth has been realised or not for African mining countries is contested. In this systematic review of literature, 13 studies found that mining boosted economic growth and 28 that it hasn't.

One approach adopted by the literature is the comparison of economic growth rate using changes in GDP, Gross National Product (GNP) or Gross National Income (GNI) per capita) of a LMI mining country or group of LMI mining countries with other countries sharing similar characteristics that are not mineral-endowed. Eight studies use this methodology with four finding that mining supports economic growth and four finding that mineral economies lag behind. The results from this comparative analysis

vary across time and are sensitive to the countries included in the mining and non-mining groups. For example, Davis (1995), Weber-Fahr, (2002), McMahon & Moreira, (2014) and a UNDP report on diamond mining in Botswana (UNDP 2014a) show that groups of mining countries have economically outperformed their peers at different time points or periods since 1970. These results contrast with those of Auty (1993, 1998a), Dobbs et al. (2013) and Haglund (2011) who show that LMI mining countries fare much worse than countries with other types of resources (e.g., oil) or without resources.

The second approach undertaken by studies entails econometric analysis, aiming to explore the role of mining dependence with variations in rates of economic growth. Most of these regressions are cross-country and cross-sectional and conclude that mining dependence have a negative impact on growth in LMI countries (Dauvin & Guerreiro 2017, Mahonye & Mandishara 2015, Ross 2001). Studies exploiting both cross-sectional and time-series variation in the data find no effect or a positive one after controlling for differences in institutional quality (Boschini, Pettersson & Roine 2007, Boschini, Pettersson & Roine 2013, Dauvin & Guerrero 2017).

At regional and local levels recent studies in Ghana and Peru compare the outcomes mining areas with qualitative data (Hoyos 2019), the Difference-in-Difference econometric methodology (Orihuela & Gamarra-Echenique 2020) or a Consumer-Producer household model (Aragòn & Rud 2016). They find that LSM leads to a “local or subnational resource curse” due to local institutions’ limited capacity to manage public investment (Hoyos 2019), a drop in agricultural production of almost 40% between 1997 and 2005 (Aragòn & Rud 2016), the short duration of any positive impacts on local consumption (Orihuela & Gamarra-Echenique 2020).

2.3.5 Is LSM a catalyst for human development?

> *"While mining has been a key driver in our strong economic growth, the industry has even greater potential to improve the well-being of all Ghanaians. The best way to make that a reality is for all segments of society to be part of planning a definite future for mining in Ghana and seeing to its implementation. Mining therefore has an integral part to play in our economy."*
>
> Honourable Minister Nii Osah Mills, Minister of Lands and Natural Resources in Ghana (ICMM 2015 p.66).

This goal, for Ghana like other LMI mining countries, does not appear to have been attained from the literature reviewed. In contrast to the economic impacts of LSM there is a strong consensus on the detrimental social impacts of LSM. Out of the 107 studies selected, only 12 outline the social benefits of mining (Chuhan-Pole, Dabalen & Land 2017, Davis 1995, Ericsson & Löf 2019, Fafchamps, Koelle & Shilpi 2015, Kotsadam & Tolonen 2016, Loayza & Rigolini 2016, Lippert 2014, McMahon & Moreira 2014, Ticci & Escobal 2015, Zambrano, Robles & Laos 2014)

The main methodology used is the comparison of social indicators for LMI mining and non-LMI mining countries, single country case studies, mining and non-mining areas.

Social impacts of LSM are mostly proxied using the Human Development Index (HDI) (e.g. McMahon & Moreira 2014, Hilson & Haselip 2004, Ross 2001), or indicators related to education and health (e.g. Davis 1995, Loayza & Rigolini 2016, Lippert 2014, Leger 1991, Lim et al. 2011, Corno & de Walque 2012, Pattanayak et al. 2010), poverty and inequalities (Loayza & Rigolini 2016, Lippert 2014, Zambrano, Robles & Laos 2014, Bulte, Damania & Deacon 2005, Hilson & Haselip 2004, Pegg 2006, Ross 2003,

Al Rawashdeh, R, Campbell, G & Titi 2016), and finally social disruption (e.g. Bainton & Macintyre 2013, Bury 2004, Chuhan-Pole, Dabalen & Land 2017, Imbun 2007).

Similar to the findings of mining dependence and economic growth, results differ widely depending on countries included, indicators chosen, and time periods considered. Furthermore, outcomes are studied at the national level but also local level. For example, at the district level in Peru, local mining revenues are found to have decreased poverty by 10.6 points over the period 2007 to 2011 according to Zambrano, Robles and Laos (2014). They also found that mining intensive districts did, on average, better than less mining intensive districts in improving literacy rates, school enrolments, life expectancy and per capita incomes. These findings were reinforced by Loayza and Rigolini (2016) who found that mining districts have higher average consumption per capita and lower poverty rates than otherwise similar districts in Peru. This contrasts with Ross (2003) who shows that mineral dependence is negatively correlated with income poverty and other development indices such as life expectancy, infant mortality and child malnutrition. As explained by Ross (2001 p.12):

> *"mineral-dependent states have significantly higher levels of inequality than other states with similar incomes: the more that states rely on mineral exports, the smaller the share of income that accrues to the poorest twenty per- cent of the population. This link is especially worrisome, since it suggests that once impoverished states become dependent on minerals exports, any subsequent economic growth tends to do little to alleviate the condition of the poor".*

Furthermore, Haglund (2011) demonstrates that more than 20 mining countries have lower levels of development than other countries, including countries dependent on oil and other fuel minerals. Thus, overall, the literature selected on social impacts is overwhelmingly negative.

The recurrence of conflicts linked to mining and the use of CSR to soften community backlash also highlight the negative social impacts of mining. The profound social disruption caused by LSM increases the likelihood of social mobilisation according to 10 of studies reviewed. A micro-level statistical analysis of the determinants of social conflict in the mining sector in Latin America revealed that a community with fewer agriculture opportunities, lower incomes and worse state services is more prone to conflict, contributing to a more general theory of firm–community conflicts (Haslam, Tanimoune & Ary Tanimoune 2016). The proportion of the population identifying as aboriginal people is much larger around communities experiencing conflict (13.49%), than communities without conflict (7.15%). In mining areas, conflicts can be multidirectional: community versus a mining company, within community members and across communities (Carstens 2009, Davis 2014, Haslam, Tanimoune & Ary Tanimoune 2016, Okoh 2014, Parker & Wood 2016, Pegg 2006, Taabazuing et al. 2012). Ross (2001, 2004) as well as De Soysa and Neumayer (2007) expose the link between civil wars and mineral dependence. Such countries include Angola or Sierra Leone (diamonds), the DRC (copper, diamonds), Liberia (diamonds, iron ore) and PNG (copper, gold). The intensity and destructive impacts of conflict can be illustrated by the cost of conflicts, which can reach hundreds of millions of dollars (Davis and Franks 2014). The way minerals are mined may also be a source of conflicts. Haslam, Tanimoune and Ary Tanimoune (2016) find that the use of cyanide in gold mining is an important cause of concern for communities and the poisoning of the environment

has been linked to social conflicts in 23 countries of Latin America. In addition, mining operated by multinational companies can also have gendered impacts with women being more affected by food insecurity (Wegenast & Jule Beck 2020).

According to four studies, multinational corporations increasingly rely on CSR as an effective way to respond to the expectations of host communities. This is demonstrated by Imbun (2007) using a survey of 500 villagers, mineworkers, town folk and other beneficiaries This has become the norm of managing mines with significant community backlash in various countries (Canavesio 2014, Carstens & Hilson 2009, Imbun 2007).

2.3.6 What are the conditions that mediate the impacts of LSM?

Despite their different views, most of the 107 studies reviewed offer recommendations on how to either mitigate negative outcomes from LSM or facilitate positive ones. They include the need to strengthen governance, foster linkages and adapt safeguards to the type of mineral mined.

It is widely accepted in the literature that poor governance is a central issue in most LMI mining countries. There are 14 studies included in this systematic review examining this issue. Using the World Bank's Worldwide Governance Indicators and UNCTAD statistics for mineral dependence, Haglund (2011) find a significant negative correlation between institutional development and mineral dependence. However, Boschini, Pettersson and Roine (2007 p.593) finds that *"countries rich in minerals are cursed only if they have low-quality institutions, while the curse is reversed if institutions are sufficiently good"*. The direct consequences of poor institutions and low levels of governance include the detrimental role of elites, corruption, inadequate mining legislation and economic imperialism.

The detrimental role of elites is illustrated profusely in the literature. Dependence on minerals does not offer the incentives to prioritise wealth creation over rent-seeking (Andrews 2018, Auty 2009, Boschini, Pettersson & Roine 2013, Dauvin & Guerreiro 2017, Smith & Dorward 2014). As discussed earlier, Auty (1998b) argues that mineral rents provide a cushion against necessary reforms, heightening the risk of corruption. In Madagascar, the national elite influence mining legislation to benefit themselves and foreign investors in terms of juridical, fiscal and customs arrangements (Canavesio 2014, Sarrasin 2006a). Inadequate mining legislation also contributes to negative impacts of LSM (Okoh 2014, Regan 2017, Taabazuing et al. 2012, Wan 2014, Wheeler 1984). Okoh (2014) finds that LSM contributes to the creation of a *"dual mining economy"* where the interests of states and mining multinational corporations are directly opposed to those of local communities and artisan and small-scale miners. The elite are often portrayed as playing a crucial role in sustaining poor governance outcomes and can be supported in these endeavours by (former) colonial powers. As a result, poor levels of governance in most mineral-rich LMI countries are hindering improvements in local living standards (Roe & Dodd 2017).

Economic imperialism or neocolonialism is discussed in eight of the studies included in this review. Jourdan (1992) notes that the very nature of LSM in South Africa is *"neo-colonial"* and as a result, puts the country in a *"structurally inferior"* position of exporting raw materials and importing capital goods. Gordon and Webber (2008) provide a similar argument in the case of Canadian mining companies in Latin America: *"capitalist imperialism […] driven by the competitive pursuit of profit based on the exploitation of labour […] involving the forceful and violent organization of peoples' lives as they are subordinated to the whims of capital"* (p. 63). Seven of the studies reviewed highlight that this economic imperialism results from the World

Bank's approach to development. World Bank officials have long maintained that in sub-Saharan Africa LSM financed and operated by foreign multinationals could become *"growth poles"* to stimulate economic development (Hilson 2019). The reforms imposed by the World Bank in the 1980s and '90s were presented as a way to foster the liberalisation of LSM industries in LMI mining countries (Bridge 2004, Campbell 2004). Roles between states and private mining companies were redefined. States as *"regulators and promoters"* and mining companies as *"owners and operators".* As a result, governments' goals to reduce poverty had to be put aside to primarily facilitate private investment in the sector (Szablowski 2007). The standards and processes enforced by the Bank had a *"legitimation effect"*. Between 1988 and 2010, a total of 35 programs of mining reform were implemented in 24 countries costing one billion dollars. Two-thirds of these reforms were undertaken in sub-Saharan Africa (Pegg 2006). Other studies (16) find that while these reforms have enabled LMI countries to receive more FDI, and partly industrialise and modernise their economies (e.g. Aryee 2001, Ericsson & Löf 2019, Fafchamps, Koelle & Shilpi 2015, Lageat 1978), strengthening governance is essential for LMI mining countries to benefit from mining.

One of the most detrimental impacts of LSM identified by the literature reviewed is the transformation of the economy into an enclave that is mostly dependent on mining. The review identified 14 studies which examine the enclave characteristics of economies with LSM. Market enclaves can result from capital-intensive industries employing a very small fraction of the domestic workforce with large inputs from foreign sources (Bainton & Macintyre 2013, Chuhan-Pole, Dabalen & Land 2017). When mining is very capital-intensive, downstream industries are far more likely to be established in developed countries (Canavesio 2014). In developing countries, the mining industry tends to stimulate distant metropolitan regions through fiscal revenues

but has modest local impacts through backward, forward or final demand channels (Hirschman 1971, Taabazuing et al. 2012). This phenomenon is often inherited from colonial times when many multinational corporation mining subsidiaries were created by colonial powers (Auty 1995, Girvan 1971, Kessel 1977, Thoburn 1977). According to Gajigo, Mutambasere and Ndiaye (2012), the industry's contribution to development is hindered both by its enclave nature and the prevalence of unfair concession agreements signed between governments and foreign mining companies. Kruijt and Vellinga (1977) argue that the mining sector in Peru led to an "*almost impregnable bastion, generating mechanisms which resist structural change in the direction of a growth pole" (p. 115).*

The main recommendation to mitigate this dependence and enclave risk and transform mining into a *"growth engine"* is to foster linkages (McMahon & Moreira 2014). Most studies place a strong emphasis on the importance of linkages between mining companies and other sectors.

> *"It is clear that mineral-rich countries can get more out of their mining sector than mines – and this can be seen without going back in history to cases like Australia, Canada, Sweden, and the United States. In many countries, substantial linkages and employment have been developed from mining operations, and tax revenues are increasing to build national and local capital, both physical and human."*
>
> (McMahon & Moreira 2014 p. 46)

In Tanzania, efforts have been made to improve the potential for local procurement, including in services such as catering, vehicle repair, machine shop services, welding, metal work, electrical work and plumbing (Chuhan-Pole, Dabalen & Land 2017). These

linkages could be fostered by improving business conditions or imposed by legal requirements. In most cases, government intervention is required to broaden the number of beneficiaries (McMahon & Moreira 2014) or boost employment by reducing the skill-lag between the needs of the industry and the education and training level of the population in many mining countries, as reported by Auty (2001) and Loayza and Rigolini (2016). For instance, in Botswana the government negotiated with De Beers to move the processing and auctioning of diamonds from London to Gaborone. This helped not only by creating more jobs (about 3,500), but also by transferring skills and improving the value added from processing diamonds (UNDP 2014a).

Finally, it is clear that all minerals are not equal. Five studies differentiate the negative impacts of mineral by their type. All these studies concur that ores and minerals are more significantly related to the resource curse than mineral fuels. Haglund (2011) shows that the greatest dependence on LSM has occurred among countries that rely on non-fuel minerals such as copper and gold mainly due to sharp increases in commodity prices. Boschini, Pettersson & Roine (2007, 2013) outline that "*the appropriability"* of some minerals makes them more likely to lead to rent-seeking, corruption or conflicts which, in turn, harm economic development. High levels of appropriability apply to ores and metals but more specifically to gold, silver and diamond. The mining of certain minerals also influences inequality. Addison, Boly and Mveyange (2017) examine the relationship between mining and spatial inequality using the night lights Gini index in 38 mining countries in Africa during 2001 to 2012. This study reveals a significant impact of mining on increasing inequality in districts producing helium, garnet, diatomite and gold.

2.4 Discussion and conclusion

Overall, there are more studies highlighting the negative economic and social impacts of LSM (634%) than nuanced (21%) or positive ones (16%), which seems to indicate that LSM tends to have detrimental impacts. Yet, these findings must be cognisant of the methodological shortcomings of the empirical studies.

Out of the 107 studies selected in this review, 57 mostly use quantitative data and 28 mixed data. In the 85 studies using quantitative and mixed data, the main indicators used to discuss the economic impacts of LSM on LMI countries are gross domestic product (GDP), gross national income (GNI) or gross national product (GNP). However, these macro indicators have some important limitations (Davis 1995, Giannetti et al. 2015, Talberth, Cobb & Slattery 2007) including (1) the failure to indicate whether economic growth is sustainable or not as it doesn't include the depletion of the asset base; (2) the failure to account for the costs imposed on human health and the environment of negative externalities arising from the production or consumption of the nation's output; and (3) the failure to account for or represent the degree of income inequality in society.

Among the 69 studies that examine the social impacts of LSM only a few of these (Campbell et al. 2007, Ericsson & Löf 2019, Roe & Samuel 2007, Ross 2001, Saha et al. 2011) use or refer to a broad set of social indicators, for example, the HDI, the Gini coefficient, primary school enrolments, adult literacy, life expectancy, infant mortality, public spending on education or health expenditures. The rest of them focus on a limited number of indicators that cannot portray a comprehensive and accurate picture of the social impacts of LSM.

Further, as Ross (2003) points out, none of the 35 studies using econometric models justify why they treat mineral dependence dichotomously instead of treating mineral dependence as a continuous variable. Dividing states into somewhat arbitrary “mineral” and “non-mineral” groups rather than examining the importance of LSM to GDP, influences findings. In addition, empirical studies often suffer from missing data. If the data are missing for reasons that are correlated with mining or another variable – for example, because of civil war or extreme poverty – results will be biased. In addition, as outlined by Loayza and Rigolini (2016) cross-country studies have suffered from uneven data quality and limited treatment of omitted variables that may correlate with resource abundance.

Beyond these limitations, most studies suffer from endogeneity issues. The impacts of LSM are in most instances studied using macroeconomic data to compute measures of resource abundance (5), resource dependence ratios such as mining exports to total exports (14), mining FDI to total FDI (1), or mining’s contribution to GDP growth (12). However, findings are likely to suffer from simultaneity bias since while mining might lead to growth, it is also likely that growth will spur mining activities. Kotsadam and Tolonen (2016) stress that these “severe endogeneity problems” are likely to be due to a national-level and cross-country-focus of the literature. They add that differences in resource abundance are endogenous to factors such as institutions, civil wars and growth, the efficiency of the economy in general and the protection of property rights can influence the search for and exploitation of resources. Furthermore, Boyce and Herbert Emery (2011) and Haglund (2011) outline that correlation is not sufficient to conclude resources are a curse, nor is it necessary to find a positive correlation between growth and resources to overturn the resource curse interpretation. *“correlation is not sufficient to conclude resources are a curse” (*Boyce

& Herbert Emery 2011 p. 2). Studies also usually fail to account for dynamic and lagged impacts of LSM. For example, Davis (2011) demonstrates that per capita resource production does not grow substantially over time and hence introduces a drag on the measured growth of per capita economic output.

While the studies included in this review mostly suggest negative impacts of LSM, this could also be due to publication bias, where researchers, referees and editors prefer some findings (such as statistically significant evidence in favour of the natural resource curse) at the expense of others.

Last but not least, economists and political scientists have largely focused on the role of mineral abundance or dependence in long-term growth at country (macro) or sometimes regional (meso) levels. Whereas anthropologists, sociologists and other social scientists have explored the development impacts of extractive industries at the community (micro) level (Gilberthorpe & Papyrakis 2015). Szablowski (2002) discusses *"disciplinary chauvinism"* characterised by a lack of understanding of or respect for the premises, methodologies and results of social science inquiry. As pointed out by Cox et al. (2016), empirical work in natural resource management cannot be as effective or efficient without a thorough understanding of the existing theories. Each of these fields, such as resource economics, political economy and the environment, has its own set of theories forming a large set of knowledge that mainly co-exists in silos despite their strong relationships (nested, related, contradictory). The lack of cross-disciplinary approaches may prevent researchers from considering alternative and suitable hypotheses or Conceptual perspectives from other fields (Cox et al. 2016, Armitage 2008).

In analysing the economic and social impacts of LSM, stakeholders' views may be fundamentally different depending on the level of analysis at macro, meso or micro levels. Out of the 107 studies selected in this review, most of them are at the macro level (52), followed by micro (47). There are only five mixed-level studies (4 macro/micro and 1 meso/micro) and three at the meso level. A closer look at these studies reveals that there is an over-representation of macro-level studies for those that are positive (12 out of 17 in total) and that meso-level studies are overall under-represented (4 out of 107), as illustrated in Figure 9.

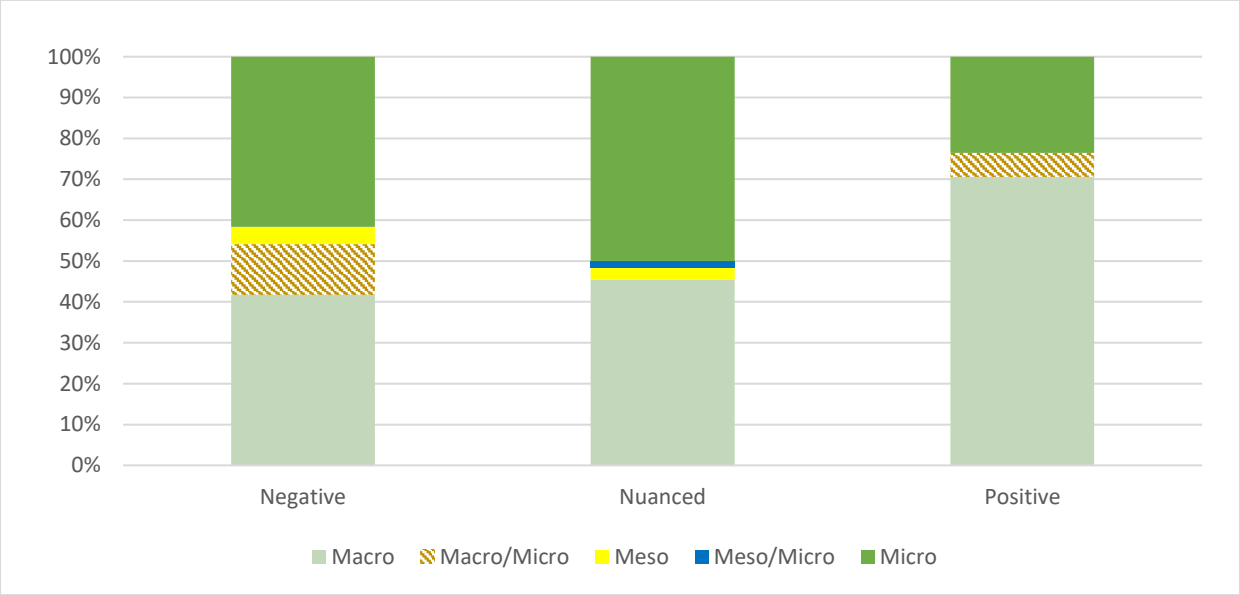


Figure 9: Level of LSM impact studied and impact

Source: Author's calculations

For Gilberthorpe and Papyrakis (2015) natural resource abundance and exploitation within a region can have significant impacts relative to mineral scarce counterpart regions. The use of a within-country methodology (meso or micro level) has been made possible with the release of household survey data and geo-localised information for mining sites (Kotsadam & Tolonen 2016, Loayza & Rigolini 2016). These studies mostly use DiD estimations for comparing non-mining and mining

districts (Aragón & Rud 2013, Chuhan-Pole, Dabalen & Land 2017, Kotsadam & Tolonen 2016, Lippert 2014, Loayza & Rigolini 2016, Ticci & Escobal 2015, Zambrano, Robles & Laos 2014). Nevertheless, these studies need to be complemented with qualitative insights. For example, in previous studies, there is no indication of whether the transition from employment in agriculture to services has been forced or voluntary. What motivated it? A business opportunity or land grabs forcing local people to find another survival means? To what extent have their long-term resilience been affected?

To conclude, it appears that to adequately assess the impacts of LSM, country, regional and local-level econometric approaches need to be augmented with the collection of primary quantitative and qualitative data using an interdisciplinary approach. Libermann (2005) outlines the "synergistic value to the nested research design", combining and informing different methodologies. This critical stance questioning the robustness of the most commonly used methodologies echoes a broader trend among researchers (Cust & Poelhekke 2015, Gilberthorpe & Papyrakis 2015, Papyrakis 2017). In *Mining, Society, and a Sustainable World* Keith, Slack (2010 p. 86) stresses the need for independent national and project-level cost-benefit analyses to be undertaken. The research and mining expert added:

> *"Such analyses should be independently produced by multi-disciplinary teams, including economists and specialists in poverty reduction, human rights, and environmental issues. These teams should have no vested interest in the outcome of the analysis."*

The insights from these different disciplines enable the understanding of the LSM impacts, how they materialise at different levels and spill across scales (Gilberthorpe & Papyrakis 2015). As a result, this thesis will not be based on a specific theory with

causal mechanisms given the contested nature of the impacts of LSM across disciplines. Rather, it will apply a pragmatic approach as presented in the Methods and methodology section (1.3) of the Introduction. Nevertheless, each chapter will be underpinned by a conceptual framework to inform and guide the analysis.

Appendix 2.1: Studies included in the systematic review

Table 3: Overview of the studies included in the systematic review (A to D)

References	Date	Pos/Neg/N	Level	Sec/Pri	Qual/Quant/Mix	Method.	Minerals	Countries	Journal/Publisher
Addison and al 2017	2017	N	Meso	Sec	Quant	○	hard minerals	multi-countries	Policy Research Working Papers
Al Rawashdeh et al 2016	2016	Neg	Meso	Sec	Quant	○	phosphate	Jordan	Extractive Industries and Society
Andrews 2018	2018	Neg	Micro	Pri	Qual	●	gold	Ghana	Resources Policy
Antwi 2017	2017	Neg	Micro	Pri	Mix	○●	gold	Ghana	Sustainability Science
Aragon 2016	2016	Neg	Micro	Pri	Mix	○●	gold	Ghana	The Economic Journal
Aragon and Rud 2013	2013	Pos	Micro	Sec	Quant	○	gold	Peru	American Economic Journal
Aragón and Rud 2016	2016	Neg	Micro	Sec	Quant	○	gold	Ghana	Economic Journal
Aryee 2001	2001	Pos	Macro	Sec	Quant	◊	hard minerals	Ghana	Resources Policy
Auty 1993	1993	Neg	Macro	Sec	Quant	◊	hard minerals	multi-countries	Routlege
Auty 1995	1995	Neg	Macro	Sec	Quant	◊	hard minerals	multi-countries	Hodder Arnold Publication
Auty 1998	1998	Neg	Macro	Sec	Quant	◊	hard minerals	multi-countries	UNU WIDER
Auty 2001	2001	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	European Economic Review
Auty 2009	2009	Neg	Macro	Sec	Quant	◊	diamond, iron, ore	Botswana,Indonesia,Venezuela	International Social Science Journal
Bainton 2013	2013	Neg	Micro	Pri	Qual	●	gold	PNG	Engaging with capitalism: Cases from Oceania
Bainton 2017	2017	Neg	Micro	Pri	Mix	◊●	gold	PNG	ANU Press
Banks 1993	1993	Neg	Macro/Micro	Sec	Mix	◊	gold, silver, copper	PNG	Applied Geography
Bazillier and Girard 2020	2020	N	Micro	Sec	Quant	○	gold	Burkina Faso	Journal of Development Economics
Bloch 2012	2012	Pos	Macro	Pri	Mix	◊●	gold	Ghana	Resources Policy
Boschini 2007	2007	N	Macro	Sec	Quant	○	hard minerals	multi-countries	Scandinavian Journal of Economics
Boschini 2013	2013	N	Macro	Sec	Quant	○	hard minerals	multi-countries	World Development
Bulte 2005	2005	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	World Development
Bury 2004	2004	Neg	Micro	Pri	Mix	◊●	gold	Peru	Geographical journal
Campbell 2010	2010	Neg	Macro	Sec	Qual		hard minerals	multi-countries	Canadian Journal of Development Studies
Campbell 2014	2014	Neg	Macro	Sec	Qual		hard minerals	multi-countries	International Development Research Centre
Canavesio 2014	2014	Neg	Micro	Pri	Qual	*●	titanium ore	Madagascar	Land Use Policy
Carstens 2009	2009	Neg	Micro	Pri	Qual	●	gold	Tanzania	International Development Planning Review
Chachage and al 1993	1993	N	Macro	Sec	Quant	◊	hard minerals	Zimbabwe,Tanzania	The Scandinavian Institute of African Studies
Chuhan-Pole et al. 2017	2017	N	Micro	Sec	Quant	○	gold	Ghana,Mali,Tanzania	World Bank
Cordes and al 2016	2016	N	Macro	Pri	Mix	◊*●	hard minerals	multi-countries	Columbia University
Corno 2012	2012	Neg	Macro	Sec	Quant	○	hard minerals	Swaziland,Lesotho	World Bank
Curtis and Lissu, 2008	2008	Neg	Macro	Sec	Mix	◊	gold	Tanzania	National Council of Muslims in Tanzania
Dauvin and Guerreio 2017	2017	N	Macro	Sec	Quant	○	hard minerals	multi-countries	World Development
Davis 1995	1995	Pos	Macro	Sec	Quant	◊	hard minerals	multi-countries	World Development
Davis and Franks 2014	2014	N	Micro	Pri	Qual	●	hard minerals	Peru	Harvard Kennedy School
De Soyza 2007	2007	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	Conflict Management and Peace Science
Dialga 2018	2018	Neg	Macro	Sec	Quant	○	gold, uranium	Burkina Faso,Niger	Journal of Cleaner Production
Dobbs and al 2013	2013	N	Macro	Sec	Quant	◊	hard minerals	multi-countries	McKinsey Global Institute

Table 3: Overview of the studies included in the systematic review (D to O)

References	Date	Pos/Neg/N	Level	Sec/Pri	Qual/Quant/Mix	Method.	Minerals	Countries	Journal/Publisher
Ecuador LSM Human rights 2010	2010	Neg	Micro	Pri	Mix	◊●	iron	Ecuador	Ecuadorian Ecumenical Commission for Human Rights
Ericsson 2019	2019	Pos	Macro	Sec	Quant	◊	hard minerals	multi-countries	Mineral Economics
Fafchamps et al. 2015	2015	Pos	Macro	Sec	Quant	○	gold	Ghana	World Bank
Girvan 1971	1971	N	Macro	Sec	Quant	◊	bauxite	Jamaica	University of the West Indies
Hadlung and al 2011	2011	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	University of Oxford
Haslam 2016	2016	Neg	Micro	Sec	Quant		gold, silver, copper	multi-countries	World Development
Hilson 2019	2019	Neg	Macro	Sec	Mix	◊	hard minerals	multi-countries	Land Use Policy
Hilson and Haselip 2004	2004	Neg	Macro	Sec	Mix		hard minerals	multi-countries	Minerals and Energy - Raw Materials Report
Hirschman 1971	1971	Neg	Macro	Sec	Quant	◊	hard minerals	multi-countries	Yale University Press
Hoyos 2019	2019	Neg	Micro	Pri	Mix	◊●	hard minerals	Peru	The Extractive Industries and Society
ICMM 2015	2015	Pos	Macro	Pri	Mix	◊*●	gold	Ghana	ICMM
Imbun 2007	2007	Neg	Micro	Pri	Quant	*	gold	PNG	Journal of Business Ethics
Jourdan 1992	1992	Neg	Macro	Sec	Qual		TBC	South Africa	University of Cape Town
Kessel 1977	1977	Neg	Macro	Sec	Quant	◊	copper, zinc	Zambia	Oxford: Clarendon Press
Koitsiwe and Adachi 2015	2015	N	Macro	Sec	Quant	○	diamond, copper-nickel	Ghana	Contaduría y Administración
Kotsadam and Tolonen 2016	2016	N	Micro	Sec	Quant	○	hard minerals	multi-countries	World Development
Kruijt 1977	1977	Neg	Micro	Pri	Mix	◊●	hard minerals	Peru	Boletín de Estudios Latinoamericanos y del Caribe
Kwabena 2017	2017	Neg	Micro	Pri	Mix	◊●	gold	Ghana	Sustainability Science
Lageat 1978	1978	Neg	Macro/Micro	Sec	Quant	◊	gold	South Africa	Les Cahiers d'Outre-Mer
Land 2017	2017	Pos	Macro	Sec	Quant	○	gold	multi-countries	World Bank
Lawson and Bentil 2014	2014	N	Micro	Pri	Qual	●	hard minerals	Ghana	Environment, Development and Sustainability
Lippert 2014	2014	Pos	Micro	Sec	Quant	○	copper	Zambia	University of Oxford
Loayza and al 2016	2016	N	Micro	Sec	Quant	○	gold, copper, silver	Peru	World Development
Mahonye and Mandishara 2015	2015	Neg	Macro	Sec	Quant	○	hard minerals	Zimbabwe	ERSA
Maliganya 2017	2017	N	Micro	Pri	Mix	*●	gold	Tanzania	REPOA
Marechal 2013	2013	Pos	Macro	Sec	Qual		hard minerals	multi-countries	Institut français des relations internationales
Mcmahon 2014	2014	Pos	Macro	Sec	Quant	◊	hard minerals	multi-countries	World Bank
Moomen and al 2016	2016	Neg	Micro	Pri	Mix	○●	gold	Ghana	Resources Policy
Mtero 2017	2017	Neg	Micro	Pri	Mix	*●	platinium	South Africa	Resources Policy
Mtero 2017	2017	Neg	Micro	Pri	Mix	*●	platinium	South Africa	Resources Policy
Nankani 1979	1979	Neg	Macro	Sec	Quant	◊	hard minerals	multi-countries	World Bank
Nyantakyi-Frimpong 2017	2017	Neg	Micro	Pri	Mix	*●	gold	Ghana	The Journal of Peasant Studies
Okoh 2014	2014	Neg	Micro	Pri	Qual	●	gold	Ghana	Futures
Orihuela 2020	2020	N	Micro	Sec	Quant	○	gold	Peru	Environment and Development Economics
Ostensson 2014	2014	Pos	Micro	Pri	Mix	◊●	gold	Chile, DRC, Gambia	Mineral Economics

Table 3: Overview of the studies included in the systematic review (P to Z)

References	Date	Pos/Neg/N	Level	Sec/Pri	Qual/Quant/Mix	Method.	Minerals	Countries	Journal/Publisher
Parker and Wood 2006	2006	Neg	Macro/Micro	Pri	Mix	◊●	gold, silver, iron	Mali	Oxfam America
Pattanayak, S. et al. 2010	2010	Neg	Micro	Pri	Mix	○●	iron ore	India	Health & Place
Pegg 2006	2006	Neg	Macro	Sec	Qual		hard minerals	multi-countries	Journal of Cleaner Production
Pokorny 2019	2019	Neg	Micro	Sec	Quant	○	gold	Burkina Faso	World Development
Quodling 1991	1991	N	Micro	Pri	Mix	◊●	copper	PNG	Centre for Independent Studies
Regan 2017	2017	Neg	Macro	Pri	Qual	●	copper, gold	PNG	ANU Press
Roe and Dodd 2016	2016	Pos	Macro	Sec	Quant	○	hard minerals	multi-countries	ICMM
Roe and Dodd 2017	2017	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	ICMM
Roe and Samuel 2007	2007	Pos	Macro/Micro	Pri	Mix	◊*	hard minerals	Ghana	ICMM
Romo et al. 2014	2014	Pos	Macro	Pri	Mix	○●	hard minerals	multi-countries	World Bank
Ross 2001	2001	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	Oxfam America
Ross 2003	2003	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	UCLA
Ross 2004	2004	Neg	Macro	Sec	Quant	○	hard minerals	multi-countries	Cambridge University Press
Sarrasin 2006	2006	Neg	Macro	Sec	Quant	◊	hard minerals	Madagascar	Journal of Cleaner Production
Seagle 2012	2012	Neg	Micro	Pri	Qual	●	titanium ore	Madagascar	Journal of Peasant Studies
Shirley 2014	2014	Neg	Micro	Pri	Qual	*●	chromite	Madagascar	Resources Policy
Smith 2014	2014	Neg	Micro	Pri	Qual	●	chromite	Madagascar	Resources Policy
Smith and Dorward 2012	2012	Neg	Micro	Pri	Qual	●	titanium ore	Madagascar	Resources Policy
Sonter and al 2014	2014	Neg	Meso	Sec	Quant	○	iron	Brazil	Journal of Cleaner Production
Sosa 2017	2017	Neg	Micro	Pri	Quant	●	copper	Peru	Human Organization
Swablowski 2007	2007	Neg	Macro	Sec	Qual		hard minerals	Peru	Hart publishing
Szablowski 2002	2002	Neg	Micro	Pri	Qual	●	copper	Peru	Journal of Business Ethics
Szablowski 2007	2007	Neg	Macro	Pri	Mix	◊*●	gold, copper	Peru	Oxford: Hart Publishing
Taabazuing 2012	2012	Neg	Micro	Pri	Qual	●	hard minerals	Ghana	African Geographical Review
Taabazuing et al. 2012	2012	Neg	Micro	Pri	Qual	●	hard minerals	Ghana	African Geographical Review
Thoburn 1977	1977	Neg	Macro	Sec	Quant	◊	tin	Malaysia	Wiley
Ticci and Escobal 2015	2015	N	Micro	Sec	Quant	○	hard minerals	Peru	Environment and Development Economics
UNDP report 2014	2014	Pos	Macro	Sec	Quant	◊	diamond	Botswana	UNDP
Wan 2014	2014	Neg	Micro	Pri	Qual	●	gold	Ghana	Extractive Industries and Society
Weber-Fahr 2001	2001	N	Macro	Sec	Quant	◊	hard minerals	multi-countries	World Bank
Wegenast 2020	2020	N	Meso/Micro	Sec	Quant	○	hard minerals	Multiple countries	International Studies Quarterly
Wegenast and Beck 2020	2020	Neg	Micro	Sec	Quant	○	hard minerals	Multiple countries	World Development
Wheeler	1984	N	Macro	Sec	Quant	○	hard minerals	multi-countries	World Development
Yankson 2010	2010	Neg	Micro	Pri	Mix	*●	gold	Ghana	Development in Practice
Zambrano 2014	2014	Pos	Micro	Sec	Quant	○	hard minerals	Peru	Inter-American Development Bank

Legend

Pos	Positive
Neg	Negative
N	Neutral/Not conclusive

Quant	Quantitative
Qual	Qualitative
Mix	Mixed

○	Econometrics
◊	Summary stats
*	Surveys
●	Interviews

Sec	Secondary
Pri	Primary

Chapter 3: Impacts of LSM in Madagascar at the national level

> *"In 2024, the mining sector will be one of the pillars of the Malagasy economy through the benefits it will produce at the national and local level; it will also be the international showcase for industrial development on the territory of the Great Island."*
>
> World Bank Lead Economist for Madagascar and Comoros (World Bank 2014 p.1)

3.1 Introduction

As discussed previously (systematic literature review, Chapter 2), there is no consensus on whether LSM is beneficial or detrimental. Economically, opinions are split; socially, they are overwhelmingly negative. What can be said about the impacts of LSM in Madagascar after 15 years of operation? How does it compare with other sub-Saharan African mining countries? Twenty-seven SSA mining countries are used for the comparison. The selected countries are Algeria, Angola, Botswana, Burkina Faso, DRC, Egypt, Gabon, Guinea, Ghana, Ivory Coast, Kenya, Liberia, Libya, Mali, Mauritania, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Tanzania, Tunisia, Uganda, Zambia and Zimbabwe.

This chapter describes the evolution of the mining rents, GDP per capita and the HDI for these 27 countries and Madagascar from 1990 to 2019. Then, ratios are calculated to position Madagascar relatively to other countries. Finally, an econometric analysis is performed to get a deeper understanding of the impact and mechanisms of LSM over time, on all mining countries selected. All these results are augmented with

insights from the qualitative data obtained from 21 interviews conducted with key informants.

The analysis of economic and social impacts of mining using GDP growth per capita and the HDI showed that Madagascar might differ from its sub-Saharan African mining neighbour countries. In terms of the trajectory of its mineral rents, GDP per capita and HDI since 1990. As for the econometric analysis, economically the results are not conclusive. Socially, LSM is negatively associated with the HDI and the results tend to show that LSM did not lead until now to the visible positive social improvements expected at the national level. Yet, the qualitative analysis seems to reveal more positive outcomes that are not captured as it is difficult to infer a relationship at this level.

The remainder of this chapter is structured as follows. Section 3.2 provides a background of the mining industry in Madagascar. Section 3.3 discusses briefly the literature on the impacts of LSM in Madagascar at national level. Section 3.4 presents the methods and methodology and outlines the data. Section 3.5 reports the results, while Section 3.6 discusses robustness checks and Section 3.7 concludes and provides policy implications.

3.2 Background: key statistics and legal framework of the mining industry in Madagascar

Further to the overview of the mining industry presented in the introduction (Chapter 1), this section highlights more specifically the key statistics and elements of the legal framework of the mining industry in Madagascar.

3.2.1 Share of LSM sector to the economy

After more than 15 years of industrial mining, Madagascar is at a turning point since it has just become a resource-rich country according to the IMF definition (Lundgren, Thomas & York 2013) with mineral exports representing at least 25% of exports for at least four years in a row as shown on Figure 10.

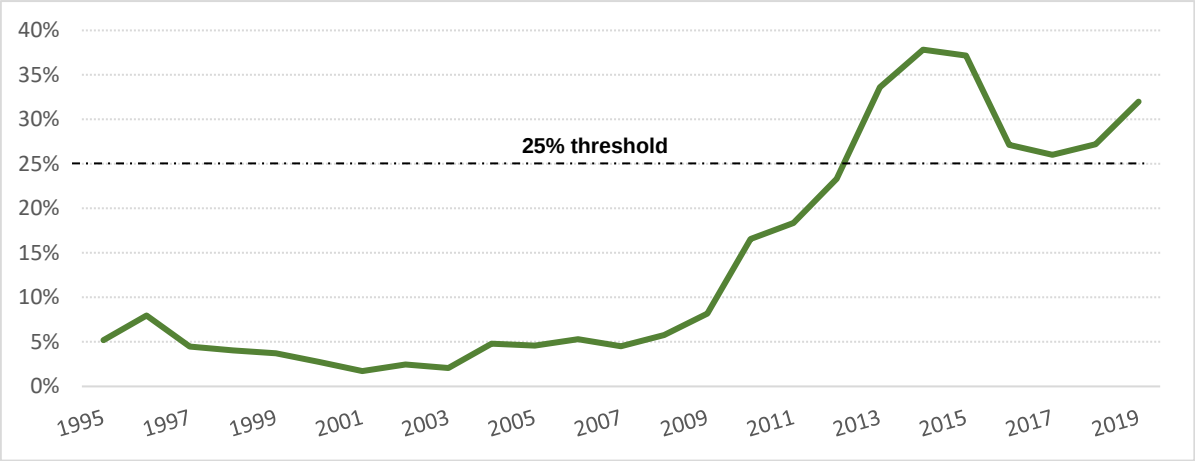


Figure 10: Mining exports in Madagascar (% of total exports)

Source: UNCTAD, Author's calculations

As for Figure 11, it illustrates the sharp increase in mineral rents since the start of QMM's operations at the end of 2008.

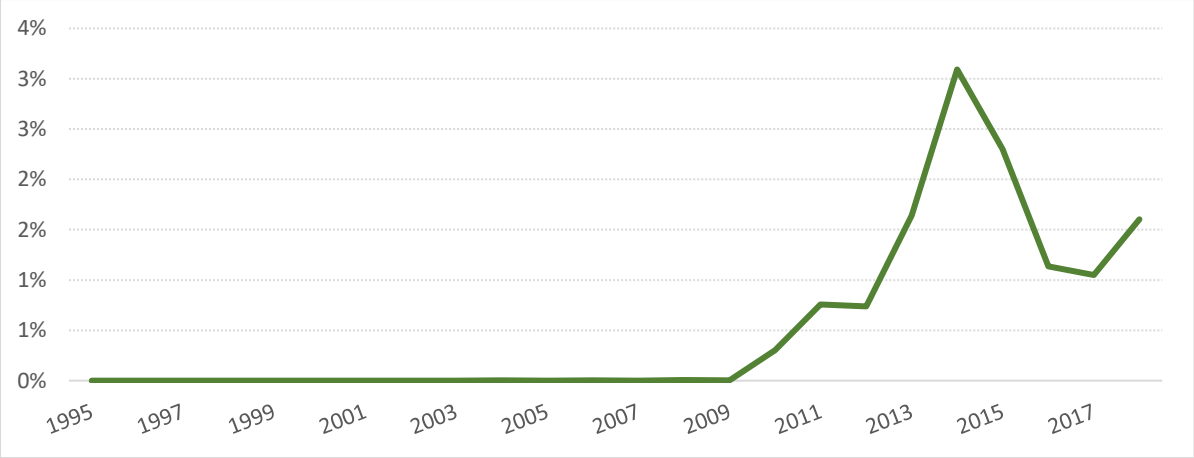


Figure 11: Mineral rents in Madagascar (% of GDP)

Source: World Bank

The rise of mineral exports and mineral rents since the start of QMM's operations offers an opportunity to lift many in the country out of poverty. More specifically, LSM is presented by international donors as one of the key strategies to drive sustainable development and economic growth (African Development Bank 2019, IMF 2020, World Bank 2015a).

3.2.2 Mining legislation

The QMM mine and the Ambatovy projets have marked the start of a new era for Madagascar. Before these foreign-led projects, Madagascar didn't have a national mining policy.

To enable first Rio Tinto and then other multinational companies invest, a mining code was developed in 1999. The design of the mining code was also informed by the World Bank (Revéret 2006, Sarrasin 2006b, Friends of the Earth 2013). To attract more of these large investments and compensate for the need to develop infrastructure and train local workforce, the mining code is considered as advantageous for investors compared to that in other sub-saharan African mining countries. *"Madagascar's royalty*

rate on mining of 2 per cent is at the lower end of the range and could be increased to 3 or 4 per cent to align with other sub-Saharan African countries' royalty rate" (IMF 2015, p. 24). Detailed information on the mining tax legislation can be found in Appendix 3.1. Despite numerous announcements (Stoddard 2017, Rabary 2019, Courage 2020) about changes to the mining code and mining taxes so mining would benefit more the country, no bill has been adopted and implemented. Moreover, there has been a suspension of new mining permits since 2011.

To better comprehend the impacts of LSM at national level in Madagascar and identify what could be improved, this chapter provides a comprehensive picture of the industry in the country as well as a comparison to other sub-saharan African mining countries. The next section is concerned with exploring the findings from the existing literature.

3.3 Literature review of the impacts of LSM in Madagascar at the national level

The reviewed literature was selected based on a two-stage process. First, the identification of references was achieved using the RMIT University library portal and Google Scholar. The search encompassed journal articles, books and reports with keywords in English and French[9] such as "impacts of industrial/Large-Scale Mining", "natural resources/extractives and development", "mining in developing countries", "mineral wealth" and "blessing/curse". All these keywords were searched alongside with "Madagascar". It appeared that they are only a few academic studies about mining in Madagascar and out of them, most are related to conservation and environmental issues.

[9] Madagascar was a French colony between 1897 and 1958 and French remains the second national language.

The publications were subsequently screened. Academic publications were scrutinised based on discipline (development economics, political economy, and in some instances environment conservation), date, abstract and methods. It must be noted that given the low number of publications related to this topic, the number of citations per article was not kept as a key criterion. As for non-academic publications, the institution and release date were the primary criteria chosen to assess the references. The references identified by these academic and non-academic publications were also used to find additional literature.

The review of the existing literature reveals disagreements between government, international donors, academics and CSOs. For previous national governments, regional and international institutions, LSM projects represent the main driver for poverty alleviation and sustainable growth. LSM should become *"an international showcase of industrial development on the territory of the Great Island"* (World Bank 2014 p. 1). Mining has been the main driver of growth first through investment and then by generating significant export earnings (Anyadike 2015, IMF 2017). Major infrastructures were developed to enable the trade of the minerals such as two ports, and 190 km of roads built or enhanced (World Bank Group 2015) in a country where nearly 70% of the roads in rural areas are not paved (Razafindrakoto, Roubaud & Wachsberger 2020). According to the forecasted benefits presented in *Measuring transformative development from mining: a case study of Madagascar* and commissioned by the World Bank (Weldegiorgis & Parra 2018), industrial mining could account for up to 14% of GDP and dominate Madagascar's exports by 2025. It should provide a steady fiscal income representing up to 11% of government revenues by 2035 if improvements are made to the mining fiscal regime. In addition, the non-fiscal effects of LSM are also expected to be significant through local procurement, which

could increase to nearly a billion US dollars per year under the most favourable scenario, with four additional mines developed and revenue management mechanisms implemented at the local level. Direct employment could also be multiplied by four (World Bank Group 2015, Weldegiorgis & Parra 2018). Thus, from the evidence brought forward by former Malagasy governments, the World Bank and the IMF, LSM projects seem to benefit the country and will continue to do so as operations scale up. This contrasts with the numerous case studies reporting the disastrous impacts on the local population.

There is a clear convergence of findings from the academic literature aiming to assess the past or current impacts of LSM in Madagascar: these projects have been extremely harmful and cannot be considered as the main solution to foster development. More could be done with the revenues from the mining industry in terms of Water, Sanitation and Hygiene (WASH) but the lack of a coherent strategy undermines any effort made (WaterAid 2018). Overall, the socio-economic benefit optimisation is rated as “low” with a lack of national optimisation framework and resources for the government to enforce its legislation (Crawford & Nikièma 2015). Ross goes even further in the journal article ‘How does mineral wealth affect the poor’ (Ross 2003). He shows that in Madagascar, LSM would drive an additional 12.5% of the population to fall below the poverty line. The issue of foreign countries benefiting from the country’s resources were at the centre of both the latest presidential campaigns (Pellerin 2009) and since then multiple announcements have been made to improve Madagascar’s mining benefits (IIAP 2019). Yet at this stage the projects related to reforming the Mining Code have stalled (IIAP 2019) and citizens’ protests have been numerous. The latter have managed to lead to the suspension of the operations of the ilmenite mine in Tulear project run by the Australian company Base Resources (IIAP 2019, Vyawahare 2019).

These events constitute another example of the social divide and competition between those who will benefit and those who are convinced they won't (Burnod, Gingembre & Andrianirina 2013, Carver 2019).

Thus, the literature on the economic and social impacts of LSM at the national level is extremely limited and there is a lack of independent and objective research available, which leads us to explore the macro impacts of LSM using a large sample of secondary and primary qualitative data.

3.4 Methods and methodology

3.4.1 Research methods

The conceptual framework used in this chapter is the one presented in the systematic literature review chapter (Figure 6). As explained in the introduction (Chapter 1) and conclusion of the systematic literature review (Chapter 2), mixed methods are used in this study. The justification for the choice of methods in this study is aligned with the rationales for mixed methods formulated by Bryman (2006): credibility, utility, context, illustration and diversity of views. More specifically, the analysis of quantitative data enables to establish relatively objective findings while the qualitative data complement and qualify these findings. Both primary and secondary data are used for triangulation.

3.4.2 Methodology at cross-country and national level

This section describes which interviews were conducted with key informants at both cross-country and national level. It also explains how the macroeconomic and statistical analysis were done.

Semi-structured interviews

Conducting semi-structured interviews provided a broad perspective on the impacts of LSM within the political and historical context. Perspectives of impacts on economy and development were collected from a wide group of stakeholders. The details of the questionnaire design, testing, sampling framework, recruitment and analysis with NVivo can be found in the introduction (Chapter 1, section 1.3.2).

Macroeconomic analysis

First, the evolution of mining indicators relative to peer sub-Saharan African mining countries since 1990 is analysed. Scatter plots are used on key economic and development indicators. This first level of analysis provides an understanding of Madagascar's positioning relative to other sub-Saharan African mining countries in regard to mineral rents, exports, GDP per capita, HDI, governance and inflation. The econometric analysis enables a rigorous analysis the impacts of the mineral industry on Madagascar using panel data.

Econometric analysis and model specification

To perform this econometric analysis, two outcome variables were selected based on the conceptual framework (see Figure 6): GDP growth per capita and the Human Development Index (HDI). The model examines whether mineral rents and exports have had a positive or negative effect on these economic (GDP growth) and social (HDI) outcomes and to what extent. It is assumed that mineral rents and exports are mostly generated by LSM and not by ASM and are therefore reliable proxies of the mining industry.

To identify the relationship between GDP growth per capita and mining, cross-country growth regressions will be estimated for all sub-Saharan African countries, in the

tradition of Papyrakis and Gerlagh (2007), Barro (2001) and Sachs and Warner (1995). The period studied will be $t_0 = 1990$ to $t_T = 2019$.

$$GDPG_{c,t} = \alpha Madagascar_c + \beta Mining_{c,t} + \gamma Spending_{c,t} + \delta HD_{c,t} + \theta X_{c,t} + \varepsilon_{c,t} \quad \textbf{(3.1)}$$

Where:

- $GDPG_{c,t}$ is the GDP growth per capita of country *c* in year *t*
- $Madagascar_c$ is a dummy variable that equals 1 if *c* = Madagascar
- $Mining_{c,t}$ is a vector of mining-related variables of country *c* in year *t:*
    - $Mineral\ rents_{c,t}$ is the mineral rent defined as the difference between the value of production for a stock of minerals at world prices and their total costs of production (World Bank 2021a)
    - $Madagascar_c * Mineral\ rents_{c,t}$ is the interaction term between the variables $Madagascar_c$ and $Mineral\ rents_{c,t}$
- $Spending_{c,t}$ is the vector regrouping spending-related variables of country *c* in year *t*:
    - $Health\ expenditure_{c,t}$ is the expenditure in health
    - $Education\ expenditure_{c,t}$ is the spending in education
- $HD_{c,t}$ is a vector of human development-related variables of country *c* in year *t*:
    - $Gross\ enrolment_{c,t}$ is the gross enrolment in primary school
    - $Infant\ mortality_{c,t}$ is the mortality rate of children below one year old

- $X_{c,t}$ is a vector of control variables including GDP per capita, population size, average governance score (using the six World Governance Indicators), Foreign Direct Investments (FDIs) and log(inflation)[10]
- $\varepsilon_{c,t}$ is the error term f country *c* in year *t*

A similar approach is applied to the analysis of the relationship between the HDI and LSM.

$$HDI_{c,t} = \alpha Madagascar_c + \beta Mining_{c,t} + \gamma Spending_{c,t} + \delta HD_{c,t} + \theta X_{c,t} + \varepsilon_{c,t} \textbf{ (3.2)}$$

Equations 3.1 and 3.2 are run using the *xtreg* command in STATA to fit both regression models to panel data. The analysis focuses on the sign, size and significance of the coefficient of the mining variables ($Mineral\ Rents$ and $Madagascar*Mineral\ Rents$).

3.4.3. Data

Primary qualitative data

The rationale for conducting semi-structured interviews with given stakeholders and the distribution of the sample are explained in the Methodology section (1.3.2), according to the guidelines of the International Council for Mining and Metals that is the peak body of the industry (ICMM 2008). More precisely, table 4 presents an overview of the semi-structured interviews conducted for assessments at the macro level.

[10] Due to a wide volatility of values and negative values with a maximum of 17.7, logInflation = log(inflation+17.7).

Table 4: Overview of the semi-structured interviews conducted for analysis at the macro level

Categories of mining stakeholders	Total
Public sector officials whose role is related to mining activities	2
LSM employees	1
Subject matter experts	10
Key stakeholders of the extractive industry	1
CSOs and NGOs	7
TOTAL	**21**

Secondary quantitative data

Annual data are preferred to period averages or lags. The rationale for this approach is discussed in the robustness section 3.6. Table 5 presents the variables used in this chapter.

Table 5: Summary statistics of variables in regressions at national level

Variables	Unit and measurement	Year	Obs	Mean	SD	Min	Max
Dependent variables							
GDP growth per capita	%	1990-2019	1,354	1.560994	7.049058	–47.59058	140.3708
Human Development Index	Index	1990-2019	1,249	.471297	.1120485	.192	.804
Explanatory variables							
Madagascar	= 1 if yes	1990-2019	1,439	.0208478	.1429244	0	1
Mining							
Mineral rents	% GDP	1990-2018	852	2.625346	5.129469	0	46.62465
Madagascar * Mineral rents	% GDP	1990-2018	852	.0148387	.166256	0	3.092405
Spending							
Health expenditure	% GDP	2000-2018	866	5.516318	2.355794	1.263574	20.41341
Education spending	% Govt spending	1990-2018	623	16.33749	5.830936	0	37.52096
Human-development related							
Gross school enrolment (in primary)	% of children in age range	1990-2019	1,106	93.78266	26.313	0	156.4042
Infant mortality	Deaths per 1,000 live births for children under 1 year old	1990-2019	1,440	33.24931	12.00502	5.6	66.5
Control variables							
GDP per capita	USD 2010	1990-2019	1,356	2092.659	2931.681	164.3366	20532.95
FDI	% GDP	1990-2019	1,342	3.975828	9.077406	–11.6248	161.8238
Governance	Average of all six governance World Governance Scores	1996-2019	997	-.6189264	.7332656	–2.449376	1.831709
Population	Number of inhabitants	1990-2019	1,432	1.61e+07	2.51e+07	69507	2.01e+08
Log (Inflation)	% of consumer price change	1990-2019	1,190	3.288666	.6041037	1.794071	10.07706

Notes: "Gross" enrolment includes students of all ages meaning that it includes students whose age exceeds the official age group (e.g., repeaters). Thus, the total enrolment can exceed the population of the age group that officially corresponds to the level of education – leading to ratios greater than 100 percent (World Bank 2021b)

3.5 Results

The results presented provide a comparison with 27 sub-Saharan African mining countries for two key mining indicators (rents and contribution to exports) on two outcome variables: an economic one (GDP growth per capita) and a social one (HDI). The selected countries are Algeria, Angola, Botswana, Burkina Faso, DRC, Egypt, Gabon, Guinea, Ghana, Ivory Coast, Kenya, Liberia, Libya, Mali, Mauritania, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Tanzania, Tunisia, Uganda, Zambia, and Zimbabwe. The comparisons are three-fold. First, an historical analysis is conducted examining the evolution of the four key variables. GDP per capita is also added to provide a comprehensive picture. Second, the positioning of Madagascar relative to these countries is studied. This is followed by an in-depth econometric analysis using data from 1990 to 2019. The quantitative findings are complemented with those from the 21 semi-structured interviews conducted with key stakeholders of the mining industry.

3.5.1 Singular trajectory for a late start

Figures 12 to 16 present the evolution of mining rents, mining exports, GDP, and GDP growth per capita and HDI. They confirm that prior to QMM and the start of its extraction at the end of 2008, mineral rents were null, unlike for Madagascar's sub-Saharan African mining counterparts.

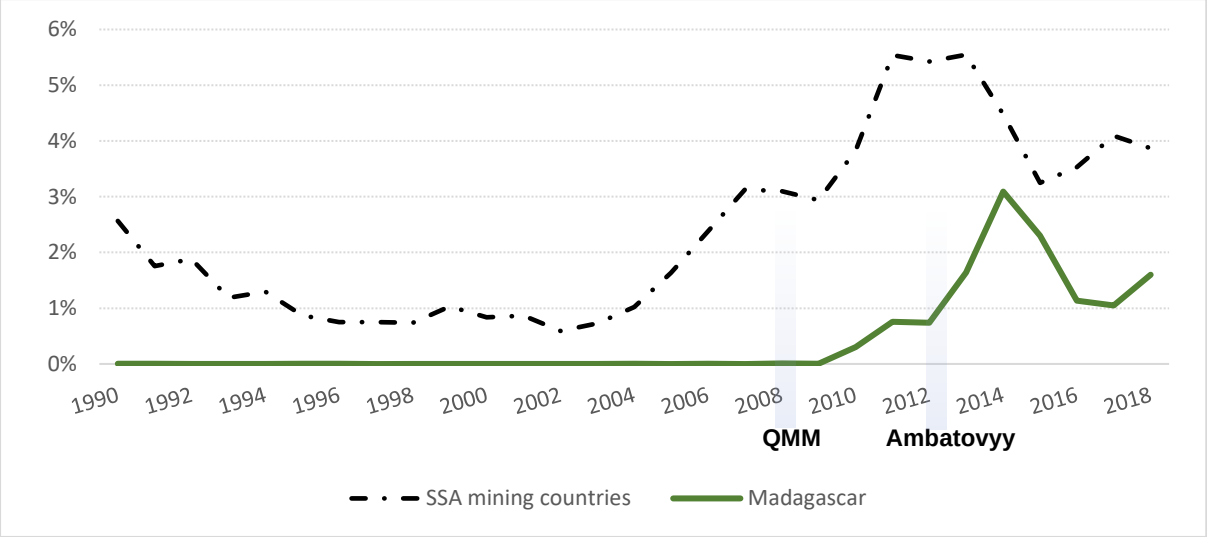


Figure 12: Evolution of mining rents since 1990 in SSA mining countries and Madagascar (% GDP)

Source: World Bank

The statistics from UNCTAD are available from 1995. They show that mineral exports grew sharply between 2009 and 2015 but fell after and haven't recovered to their peak level of 38% in 2015, whereas other sub-Saharan African mining countries have experienced more progressive and steady export growth on average as shown on Figure 13. Yet, it is worth noting that Madagascar has experienced several years where its mineral exports exceeded the one of its counterparts, which illustrates the growing importance of its mining industry relatively to the rest of its economy. Prior to QMM, mining exports in Madagascar were below 4% of total exports on average.

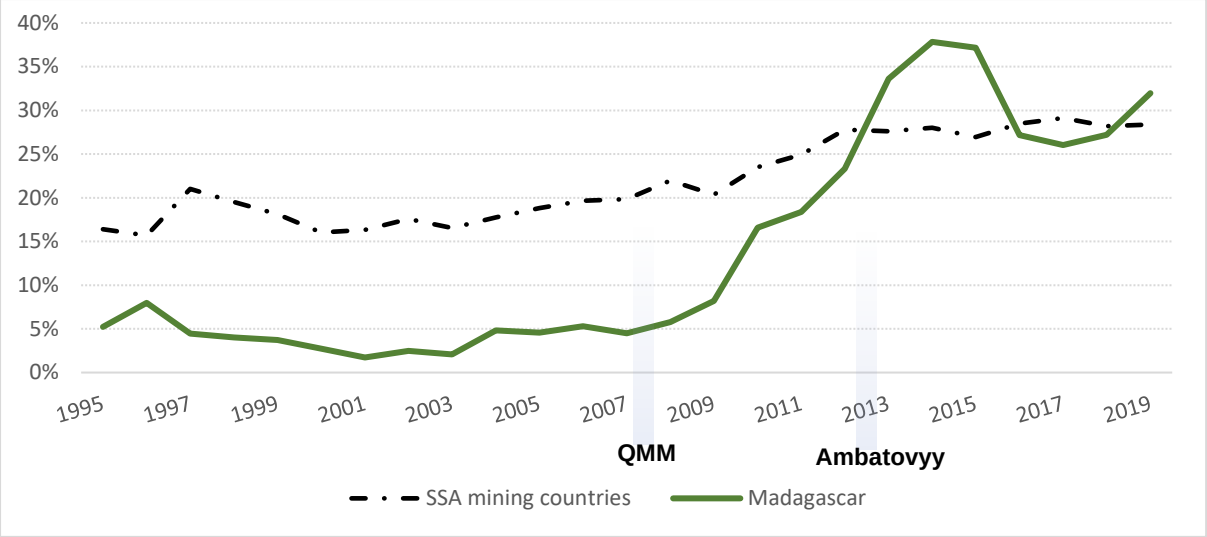


Figure 13: Evolution of mining exports since 1995 in SSA mining countries and Madagascar (% total exports)

Source: UNCTAD

The figures also show that Madagascar's GDP per capita has remained almost constant since 1990 while the average GDP per capita of sub-Saharan African mining countries has increased by nearly 60% over the same period. As a result, the gap has widened from 65% in 1990 to 81% in 2019 as can be seen on Figure 14.

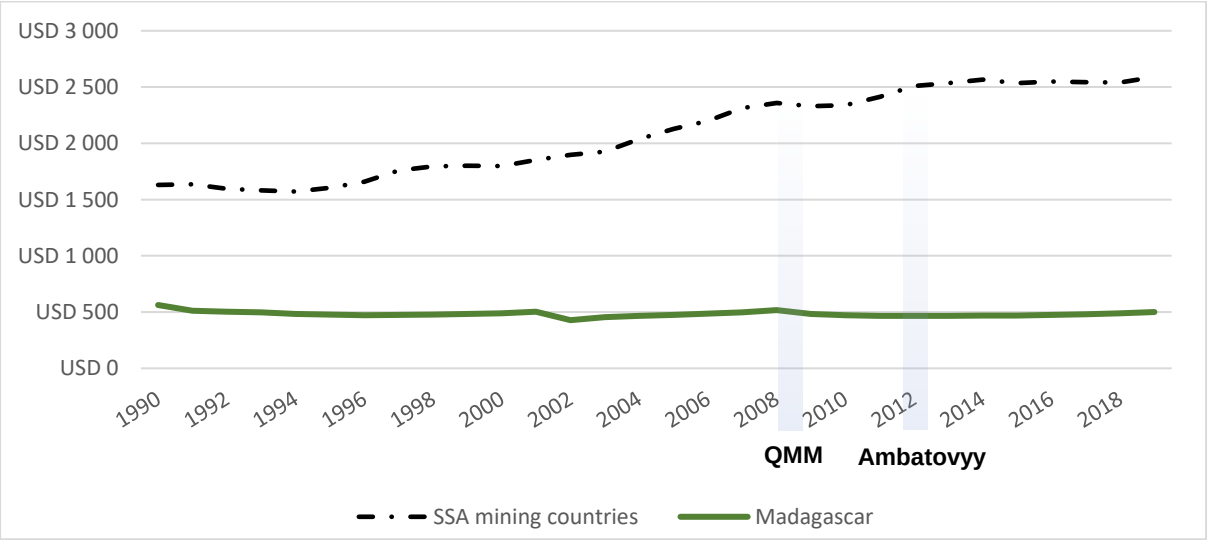


Figure 14: Evolution of GDP per capita since 1990 in SSA mining countries and Madagascar (USD 2010)

Source: World Bank

Figure 15 illustrates the fluctuations of GDP growth per capita compared to sub-Saharan African mining countries on average. These growth slumps occurred during political and economic crises, as explained in the Introduction chapter.

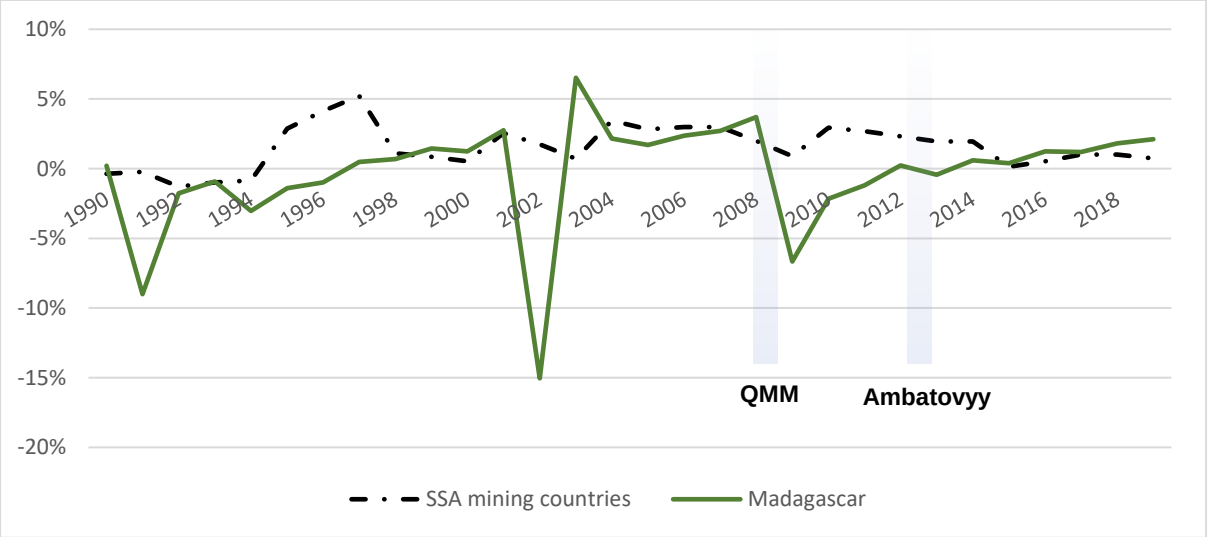


Figure 15: Evolution of GDP growth per capita since 1990 in SSA mining countries and Madagascar (%)

Source: World Bank

Finally, the HDI for Madagascar was consistently higher than the average of other sub-Saharan African mining countries (and rising) until the political crisis of 2008. As specified in the background chapter, the former President Ravalomanana was ousted, and a Temporary Authority led by the current President Rajoelina was established. Most international donors cut their aid funding during this period and international trade also dropped (OECD 2010). Since then, the country's HDI has grown at a considerably lower pace and was overtaken in 2013 by its counterparts (on average) shows Figure 16.

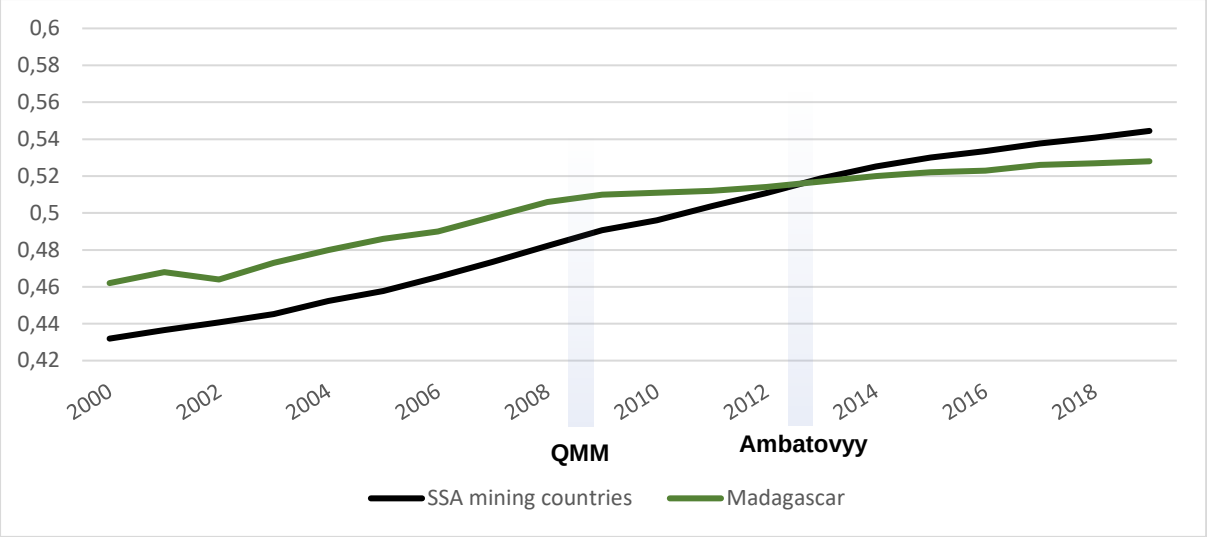


Figure 16: Evolution of HDI since 2000 in SSA mining countries and Madagascar

Source: UNDP

Given the lack of data from UNCTAD on mining exports prior to 1996 for sub-Saharan African mining countries, the rest of the study will use mineral rents as a proxy for LSM activities.

3.5.2 Madagascar stands out and lags behind

Figures 17 and 18 plot 10-year averages of GDP growth per capita and HDI by mining rents from 2010 to 2019 (except for mining rents for which the average is from 2009 to 2018 due to data availability). The trendlines show that for each additional per cent of mineral rents, on average GDP growth per capita increases very slightly and HDI declines. Yet, these ratios also show that Madagascar stands out, which is represented by the distance of the Madagascar ratios from the linear trendlines. Indeed, Madagascar has a lower GDP growth per capita and a lower HDI score than predicted by its level of mineral rents. Madagascar has the third lowest GDP growth per capita after Angola and South Africa and the eleventh lowest HDI after Nigeria and before Rwanda.

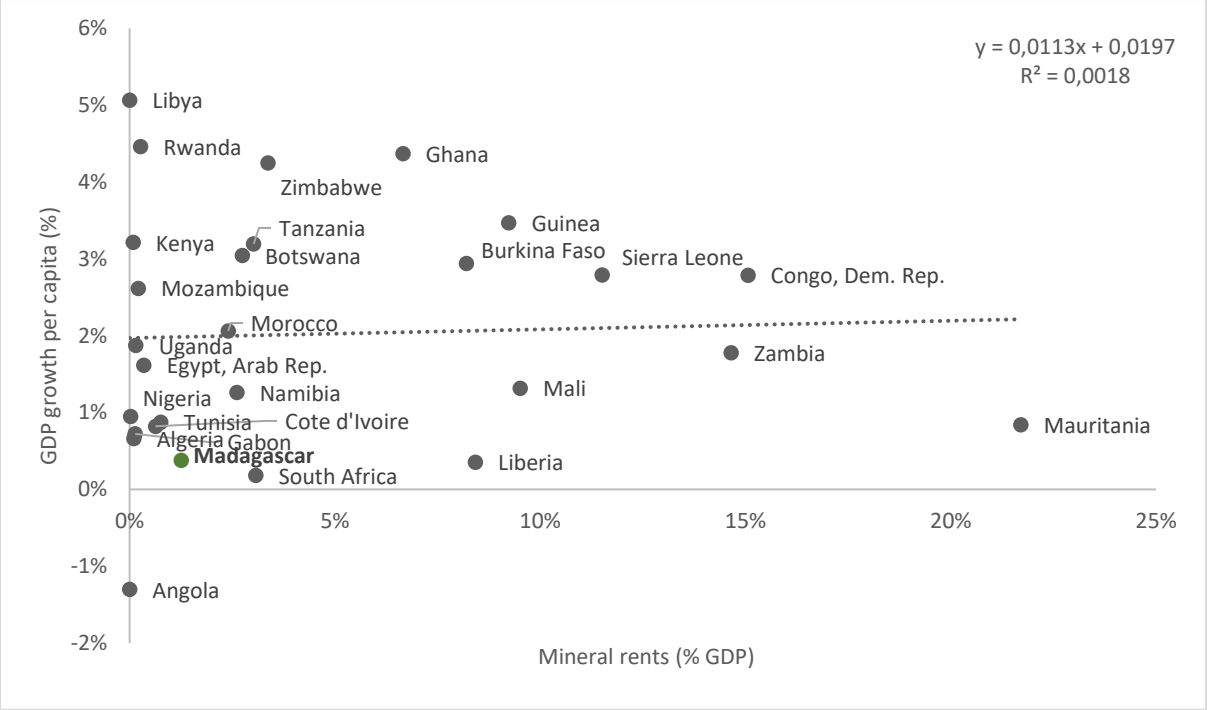


Figure 17: 10-year average GDP growth per capita (2010-2019) by mineral rents (2009-2018)

Source: World Bank, UNCTAD, Authors' calculation

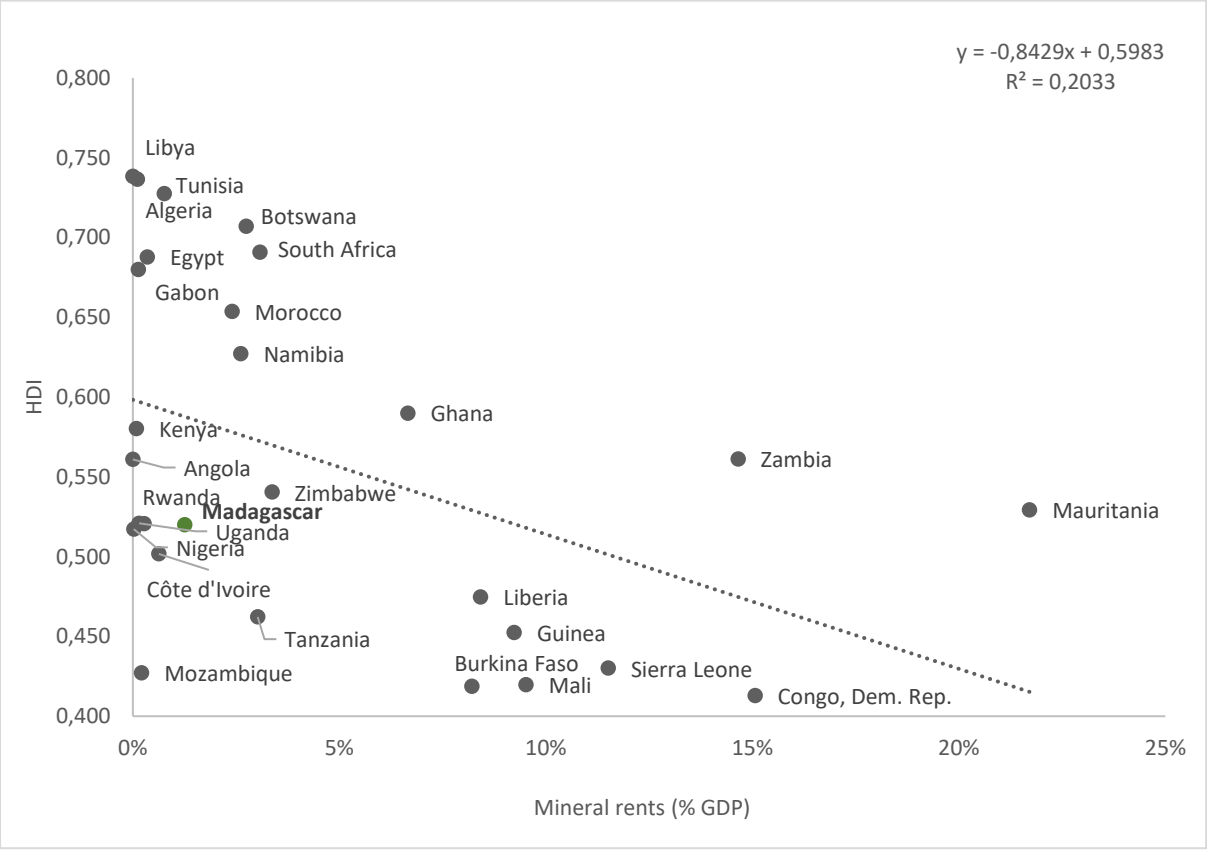


Figure 18: 10-year average HDI (2010-2019) by mineral rents (2009-2018)

Source: UNDP, UNCTAD, Authors' calculation

According to key national stakeholders and mining experts, Botswana represents a successful model of making the most out of mining revenues mainly thanks to appropriate fiscal policies and government intervention. *“Madagascar, just like most sub-Saharan mining countries dream of being Botswana. It is compared to how well Nordic countries have dealt with their natural resources”,* said a mining employee of one of the largest mining companies. This person added, *“government control and diversification of the economy are essential for these countries to close the gap”.*

This first level of analysis confirms that Madagascar cannot simply be studied using findings for other countries or groups of countries. It is also not possible to conclude that mineral rents have economically and socially negative impacts in sub-Saharan African mining countries. Yet, the analysis examines impacts over a short period of time (10-year averages). In order to better understand whether Madagascar has benefited from mining and how it compares to other sub-Saharan African mining countries during the period of 1990 to 2019, an econometric analysis is conducted in the next section.

3.5.3 Economic mystery but negative social impacts

The econometric analysis using equations (3.1) and (3.2) reveals that mineral rents are positively associated with GDP growth per capita of sub-Saharan African mining countries (see Table 6). A ten per cent increase in mining rents (relative to GDP) is associated with a higher growth between 1.3 and 2.3 per cent as shown in columns (1), (2) and (3). The coefficient on the Madagascar mineral rents interaction term is not statistically significant implying that we cannot reject the hypothesis that the relationship between mineral rents and GDP growth per capita is any different to the one of sub-Saharan countries on average. Most interviewees had the intuition that mining revenues – if well spent – could make a difference for the country's economy and its inhabitants. A government representative asserted that *"The benefits on the economy haven't been properly measured but it must have had positive impacts on government revenues, spending in infrastructure and basic services for example"*.

Table 6: Results of the panel data and time series regressions for GDP growth per capita, estimation of equation 3.1

		(1)	(2)	(3)
Type	**Variables**	**GDPG1**	**GDPG2**	**GDPG3**
Mining variables	Madagascar * Mineral rents	1.128	1.160	1.039
		(1.084)	(0.848)	(0.829)
	Mineral rents	0.126***	0.218***	0.227***
		(0.048)	(0.048)	(0.052)
Spending variables	Education expenditure		-0.067	-0.012
			(0.049)	(0.053)
	Health expenditure		-0.020	-0.020
			(0.170)	(0.210)
Human-development related variables	Infant mortality			-0.059
				(0.161)
	Gross school enrolment			0.059**
				(0.026)
Control variables	GDP per capita	-0.001***	0.001	0.000
		(0.000)	(0.001)	(0.001)
	Governance	4.002***	5.941***	5.565***
		(1.030)	(1.182)	(1.242)
	FDI	-0.021	-0.007	0.011
		(0.023)	(0.029)	(0.049)
	Population	-0.000	0.000**	0.000**
		(0.000)	(0.000)	(0.000)
	Log Inflation	-2.094***	-0.143	-0.577
		(0.699)	(1.247)	(1.274)
Additional information	FE	Yes	Yes	Yes
	Year dummies	Yes	Yes	Yes
	sigma_u	4.7329022	5.9461916	5.8852783
	sigma_e	3.8787016	2.8075141	2.6928205
	rho	.59822537	.81770912	.8268879
	F-test	F(26,520)=4.68	F(26,276)=4.18	F(28,234)=4.10
	Prob > F	0.000	0.000	0.000
	Constant	15.418***	-1.009	-3.369
		(2.750)	(4.591)	(8.218)
	Observations	582	335	294
	R-squared	0.190	0.297	0.329
	Number of countries	36	33	32

Notes: Standard errors in parentheses and clustered at the country level. Column 1 shows results of panel analysis with GDP growth per capita as dependent variable and independent mining variables. Column 2 shows results of panel analysis with mining variables, spending variables (explanatory variables 1). Column 3 shows results of panel analysis with mining variables, spending variables and human development-related variables (explanatory variables 2). All regressions included country fixed effects and were run using the xtreg command. The dummy Madagascar was omitted due to collinearity. ***p < 0.01, **p < 0.05, *p < 0.1

Yet, the low level of revenues due to the mining legislation in place made interviewees relativise this impact. “One of the critical issues lies in the low level of royalties and the numerous tax breaks or exemptions” deplored the Head of a Civil Society Organisation. Another major area of concern for a mining expert was the delayed repatriation of currency proceeds from the sale of mining exports.

> *“When the mining legislation was developed, they (the government) did not think of how delayed repatriation of currency proceeds from the sale of mining exports would hurt the economy here in Madagascar and would become an issue for the nation. Moreover, because of this oversight, the expected currency reevaluation of the Malagasy Ariary hasn’t happened. Instead, its value has kept on decreasing.”*

As for social impacts, the results presented in Table 7 suggest that the coefficients of mineral rents for sub-Saharan African mining countries are not significant. However, the findings from column (1), (2) and (3) reveal that mineral rents are negatively associated with the HDI in the case of Madagascar. As such, a ten per cent increase in mining rents is associated with a lower HDI of approximately 1 per cent. Nevertheless, interviewees, by in large, highlighted the positive – but unquantifiable at this stage – social impacts of LSM. For example, they outlined the fact that these multinational companies are bound to international standards in terms of human resources, business practices and even human rights. Beforehand, these were hardly abided by with respect to domestic businesses. Their enforcement by the LSM companies have already fostered more businesses to do the same, which is crucial in a country where most of the population has limited personal autonomy and individual rights (Freedom House 2021). For a few of the interviewees in particular, the presence

of mostly foreign-owned companies has led to stronger citizen engagement and CSO networks. *“We had to get organised and collaborate more. Before the arrival of the big mines, there was hardly any national coordination”* highlighted a CSO worker. The representative of a Business Rights coalition added:

> *“For the longest time citizens in Madagascar thought they were neither entitled not able to obtain information about business dealings. Since the arrival of QMM and Ambatovy the dynamic has changed. They’ve understood that it’s their right and it is owed to them.”*

Table 7: Results of the panel data and time series regressions for HDI, estimation of equation 3.2

		(1)	(2)	(3)
Type	**Variables**	**HDI1**	**HDI2**	**HDI3**
Mining variables	Madagascar * Mineral rents	-0.010***	-0.011***	-0.011***
		(0.004)	(0.002)	(0.002)
	Mineral rents	-0.000	0.000	-0.000
		(0.000)	(0.000)	(0.000)
Spending variables	Education expenditure		0.000***	0.000
			(0.000)	(0.000)
	Health expenditure		-0.000	-0.001*
			(0.000)	(0.001)
Human-development related variables	Infant mortality			0.000
				(0.000)
	Gross school enrolment			0.000***
				(0.000)
	Governance	0.027***	0.017***	0.013***
		(0.003)	(0.003)	(0.003)
	FDI	-0.000	0.000**	-0.000
		(0.000)	(0.000)	(0.000)
	Population	0.000	0.000***	0.000***
		(0.000)	(0.000)	(0.000)
	Log Inflation	0.000	0.006*	0.007**
		(0.002)	(0.003)	(0.003)
Additional information	FE	Yes	Yes	Yes
	Year dummies	Yes	Yes	Yes
	sigma_u	.07689188	.08215856	.07640099
	sigma_e	.01261221	.00762107	.00693457
	rho	.97380059	.9914689	.99182896
	F-test	F(25,513)=202.45	F(25,277)=243.08	F(27,235)= 226.79
	Prob > F	0.0000	0.0000	0.0000
	Constant	0.420***	0.360***	0.316***
		(0.010)	(0.012)	(0.021)
	Observations	574	335	294
	R-squared	0.908	0.956	0.963
	Number of countries	36	33	32

Notes: Standard errors in parentheses and clustered at the country level. Column 1 shows results of panel analysis with HDI as dependent variable and independent mining variables. Column 2 shows results of panel analysis with mining variables, spending variables (explanatory variables 1). Column 3 show results of panel analysis with mining variables, spending variables and human development-related variables (explanatory variables 2). All regressions included country fixed effects and were run using the xtreg command. The dummy Madagascar was omitted due to collinearity. ***p < 0.01, **p < 0.05, *p < 0.1

3.6 Robustness checks

Since we used actual annual data in our results section, the robustness tests will be focused on exploring the results obtained with lagged data first (year -1 and year -2), then averaged data (two-year and three-year averages). Then, we test for serial correlation of GDP growth and HDI. Finally, we use the Instrumental variables (IV) system General Method of Moments (GMM) estimator since it is the predominant estimation technique for models with endogenous variables when the time horizon is relatively short. At macro level, it is commonly accepted to use lagged data or averages to (Bassanini 2001). The equations were run with lagged mining rent variables (year-1 in Colum 2 and year-2 in Column 3, tables 8 and 9) to account for the delay between mining revenues and impacts through the spending and human development channels. Further, data were averaged over two- and three-year periods (two-year in Column 4 and three-year in Column 5, tables 8 and 9) to smooth annual fluctuations. These tests show that all significant coefficients have the same sign than the than the regression using actual data (Column 1 in tables 8 and 9), which confirms the validity of this model. Yet, with lagged and averaged data, fewer coefficients are statistically significant in these regressions. Moreover, they have overall fewer observations and less explanatory power (smaller R^2) than the regression using actual data. Thus, using annual data appears to be justified and our results are confirmed. Furthermore, the presence of serial correlation in the model has been verified through the Wooldridge Serial Correlation Test for Panel Data (Wooldridge 2002). This test uses the predicted values of the residuals of the first difference regression, then checks the correlation between the residual of the first difference equation and its first lag. If there's no serial correlation, the correlation should have a value of -0.5. There

is no first order serial correlation for Equation 3.1 with GDP growth (F(1, 26) = 4.45, Prob> F=0.0446) but the null hypothesis is strongly rejected for Equation 3.2 with HDI (F(1,26)=87.30, Prob> F=0.0000) and thefore has serial correlation problems. To correct for it, we regress Equation 3.2 with the Newey-West standard errors for panel data that adjusts the standard errors of the estimated regression coefficients but not the estimates themselves (Stata 2017). We find that HDI is positively associated with mining rents and significant at the 0.01 level for sub-Saharan countries but the coefficient is close to 0 (0.002) and therefore considered meaningless. As for the interaction term for Madagascar the coefficient is not significant. Therefore, our analysis is confirmed. The last test performed was the IV/GMM estimator using xtdpdsys which is a dynamic panel-data (DPD) estimator. This is valid only if there is no serial correlation in the idiosyncratic errors (Stata 2021). Results suggest that this assumption holds as shown in Table 10, columns 1 and 2. The details of the IV generated are presented in the notes under the latter table.

Table 8: Results of robustness tests for equation 3.1 using lagged data and yearly averages for GDP growth per capita

		(1)	(2)	(3)	(4)	(5)
Type	**Variables**	**GDPG Actual year**	**GDPG2 Year -1**	**GDPG3 Year-2**	**GDPG4 2-year average**	**GDPG5 3-year average**
Mining variables	Madagascar * Mineral rents	1.039	1.150	1.394	1.729	0.914
		(0.829)	*(0.840)*	*(0.931)*	(1.179)	(1.275)
	Mineral rents	0.227***	0.146**	–0.052	0.211***	0.019
		(0.052)	(0.062)	(0.059)	(0.072)	(0.082)
Spending variables	Education expenditure	-0.012	–0.062	–0.095*	-0.012	-0.062
		(0.053)	*(0.054)*	*(0.054)*	(0.070)	(0.069)
	Health expenditure	-0.020	–0.284	–0.208	-0.397*	0.007
		(0.210)	*(0.215)*	*(0.223)*	(0.236)	(0.258)
Human-development related variables	Infant mortality	-0.059	0.058	–0.047	-0.044	0.166
		(0.161)	*(0.169)*	*(0.166)*	(0.187)	(0.160)
	Gross school enrolment	0.059**	0.072***	0.059**	0.055*	0.043
		(0.026)	*(0.027)*	*(0.026)*	(0.031)	(0.029)
Control variables	GDP per capita	0.000	0.001	0.001	-0.001	-0.001
		(0.001)	*(0.002)*	*(0.002)*	(0.002)	(0.002)
	Governance	5.565***	5.330***	5.239***	6.903***	3.799**
		(1.242)	*(1.250)*	*(1.241)*	(1.613)	(1.554)
	FDI	0.011	0.019	–0.013	0.066	0.029
		(0.049)	*(0.049)*	*(0.050)*	(0.068)	(0.035)
	Population	0.000**	0.000	0.000	0.000**	0.000*
		(0.000)	*(0.000)*	*(0.000)*	(0.000)	(0.000)
	Log Inflation	-0.577	–1.632	–1.915	-0.032	-0.234
		(1.274)	*(1.338)*	*(1.358)*	(2.021)	(2.132)
Additional information	Constant	-3.369	–1.806	5.384	-2.185	-6.417
		(8.218)	*(8.906)*	*(8.710)*	(10.526)	(9.832)
	Observations	294	284	286	195	155
	R-squared	0.329	0.297	0.281	0.301	0.234
	Number countries	32	33	33	32	34

Notes: Standard errors in parentheses and clustered at the country level. Column 1 shows results of panel analysis with all variables using actual data with GDP growth per capita as dependent variable. Column 2 shows results of panel with data of the precedent year and Column 3 uses data two years before. Columns 4 and 5 present the results with 2 and 3-year averages. All regressions included country fixed effects and were run using the xtreg command. The dummy Madagascar was omitted due to collinearity. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 9: Results of robustness tests for equation 3.2 using lagged data and yearly averages for HDI

		(1)	(2)	(3)	(4)	(5)
Type	**Variables**	**HDI Actual year**	**HDI Year -1**	**HDI Year-2**	**HDI 2-year average**	**HDI 3-year average**
Mining variables	Madagascar * Mineral rents	-0.011***	-0.011***	-0.011***	-0.012***	-0.011**
		(0.002)	*(0.002)*	*(0.002)*	*(0.003)*	*(0.005)*
	Mineral rents	-0.000	-0.000**	-0.000*	0.000	-0.000
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Spending variables	Education expenditure	0.000	0.000	0.000*	0.000	0.000
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
	Health expenditure	-0.001*	-0.001	-0.000	-0.001	-0.000
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
Human-development related variables	Infant mortality	0.000	-0.000	-0.000	-0.001	-0.001**
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.001)*
	Gross school enrolment	0.000***	0.000***	0.000***	0.000***	0.000***
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
	Governance	0.013***	0.012***	0.013***	0.018***	0.024***
		(0.003)	*(0.003)*	*(0.003)*	*(0.004)*	*(0.006)*
	FDI	-0.000	-0.000	0.000	0.000	-0.000
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
	Population	0.000***	0.000***	0.000***	0.000***	0.000***
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
	Log Inflation	0.007**	0.004	0.005	0.007	0.009
		(0.003)	*(0.003)*	*(0.003)*	*(0.005)*	*(0.008)*
Additional information	Constant	0.316***	0.343***	0.341***	0.365***	0.383***
		(0.021)	*(0.022)*	*(0.021)*	*(0.028)*	*(0.037)*
	Observations	294	284	286	195	155
	R-squared	0.963	0.963	0.964	0.966	0.962
	Number countries	32	32	33	32	34

Notes: Standard errors in parentheses and clustered at the country level. Column 1 shows results of panel analysis with all variables using actual data with HDI as dependent variable. Column 2 shows results of panel with data of the precedent year and Column 3 uses data two years before. Columns 4 and 5 present the results with 2 and 3-year averages. All regressions included country fixed effects and were run using the xtreg command. The dummy Madagascar was omitted due to collinearity. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 10: Results of robustness tests applied to equations 3.1 and 3.2 using the system General Method of Moment (sysGMM) for GDP growth per capita and HDI

		(1)	(2)
Type	**Variables**	**SysGMM-GDPG**	**SysGMM-HDI**
	GDPG, log	0.096	
		(0.073)	
	HDI, log		0.930***
			(0.033)
Mining variables	Mineral rents	0.208***	0.000***
	Madgascar*Mineral rents	(0.054)	(0.000)
Spending variables	Education expenditure	-0.060	-0.000
		(0.088)	(0.000)
	Health expenditure	0.121	0.000
		-0.060	-0.000
Human-development related variables	Infant mortality	0.047	0.000
		(0.172)	(0.000)
	Gross school enrolment	0.043	0.000***
		(0.028)	(0.000)
Control variables	Governance	-0.172	0.005
		(1.325)	(0.003)
	FDI	-0.095	0.000***
		(0.071)	(0.000)
	Population	-0.000	0.000
		(0.000)	(0.000)
	Log Inflation	-1.435	0.005***
		(1.038)	(0.002)
Additional information	Constant	43.179	0.097
		(316.985)	(0.391)
	Year dummies	Yes	Yes
	Groups/Instruments	32/225	32-225
	Observations	294	294
	Number countries	32	32

Notes: Standard errors in parentheses and clustered at the country level. Column 1 shows results of the GMM estimationof the equation 3.1 where GDPG is the dependent variable. Instruments for differenced equation: GMM-type: L(2/.).GDPgrowthcapita; Standard: D.MadaRents D.Rents D.FDI D.Education_spendingGvtexp D.Healthexp D.Governance D.Infant_mortality, D.Gross_school_enrolment D.Population D.LogInflation D.GDPpercapita D.year. Instruments for level equation, GMM-type: LD.GDPgrowthcapita, Standard: _cons. Column 2 shows results of GMM estimation of the equation 3.2 where HDI is the dependent variable. The regressions were run using the xtdpdsys command. The dummy Madagascar was omitted due to collinearity. Instruments for differenced equation: GMM-type: L(2/.).HDI; Standard: D.MadaRents D.Rents D.FDI D.Education_spendingGvtexp D.Healthexp D.Governance D.Infant_mortality, D.Gross_school_enrolment D.Population D.LogInflation D.year Instruments for level equation, GMM-type: LD.HDI, Standard: _cons. ***p < 0.01, **p < 0.05, *p < 0.1.

3.7 Conclusion

The analysis of economic and social impacts of mining showed that Madagascar differs from its sub-Saharan African mining neighbour countries and lags behind, especially in terms of GDP per capita, mining rents and HDI. As for the econometric analysis, economically the results are not conclusive, which may be due to the relative recency of the mining industry in Madagascar compared to other sub-Saharan African mining countries. Socially, LSM is negatively associated with the HDI. Even though causality can't be established our findings outline that LSM has not led yet to the visible positive social improvements expected at the national level. Yet, the qualitative analysis seems to reveal more positive outcomes that are not captured as it is difficult to infer a relationship at this level.

Nevertheless, these findings could be used to nuance the current discourse on the impacts of LSM between the different mining stakeholders. They could also contribute to inform changes to the current legal mining framework and investment strategies of mining companies to ensure LSM has a greater impact on GDP growth per capita, similarly to other sub-Saharan African mining countries.

In order to refine these findings, the next chapter of this thesis will be dedicated to studying the impacts of LSM at the regional level.

Appendix 3.1: Detailed mining fiscal frameworks

Description	Mining Code
Stability commitment by the State	8 to 20 years.
Royalties upon first sale	2% of the value of mining products when the first sale takes place
Income Tax	Common law : 20% Minimum levy: MGA 100,000 + 0.5% of turnover (VAT excluded)
Income Tax on dividends	20% of dividend amount received
VAT	20% of sales
Income Tax on wages and similar	>MGA 250.000 : 20%

The special regimes in the mining sector (the Convention of Establishment and LMIA) have their own fiscal framework, which also refers to the General Tax Code. A description of the types of flows is set out below.

Framework	Content
Mining Agreement	The unique mining agreement has been signed beetween the Government and QMM. The company is not required to pay the rates of common law, but has specific fiscal advantages as summarised below. (1) Reduction of tax payable on income and mobilised capital.[42] (2) A decrease of the tax base for the flat rate tax on transfers; (3) VAT at 0%; (4) Exemption from registration fees; (5) A lower single rate for the Tax on Insurance Contracts; (6) A decrease in the rate of Property Tax on property constructed; (7) The stability of fiscal rates and thresholds.
Large Mining Investment Act (LMIA)	This law applies to companies with an investment volume of more than MGA 50 billion. Only the Ambatovy Project is currently under the LGIM. The mining company is therefore subject to the following fiscal regime: (1) A reduction of the tax base to the flat rate tax on transfers; (2) The right to reimbursement of VAT credits; (3) A lower tax rate and cap on registration fee; (4) A lower tax rate and cap on property constructed; (5) The stability of fiscal rates and thresholds.

Source: WaterAid and Moore Stephens 2018, p18

Chapter 4: Impacts of LSM in Madagascar at the regional level

4.1 Introduction

An objective of mining regions has been to leverage LSM activities to support their regional development in the long term (CREAMa, CREAMb, CREAMc, CREAMd, CREAMe, Direction Régionale de l'économie et du plan à Anosy 2016). This is echoed in the strategy of most of the large mines. Nevertheless, the number of protests against existing mines or new extractive projects seem to reveal that regional populations are not favourable to mining. After more than 15 years of LSM, what can be said about the economic and social impacts at the regional level?

The exploration of regional impacts of LSM are a relatively recent focus of analysis in the literature compared to studies at national and local levels (Aragón & Rud 2013, Loayza & Rigolini 2016, Chuhan-Pole, Dabalen & Land 2017) and as a result there are fewer references available. The novelty of this chapter is that it applies a similar approach to the seminal studies in this field to Madagascar, augmented with qualitative data collected from LSM stakeholders in Madagascar during fieldwork completed in May to August 2019. It explores how the benefits from the mining sector are captured by communities and measures the magnitude of the impact of mining at a meso level; that is, within mining districts and up to 60 km from a mine. This study uses geo-localised secondary data from the Demographic Health Survey (DHS) for 2008 and Malaria Indicator Survey (MIS) for 2016 to examine impacts near the six large-scale mines currently in activity in Madagascar.

This analysis reveals that mining districts have benefited less from mining than neighbouring districts thanks to spillover effects through employment (direct, indirect, and induced), mining revenues and infrastructures developed. This is also likely to be due to the migration of poorer migrants to mining districts, while neighbouring districts have experienced less migration but benefited from the infrastructures and facilities built, regional economic development and potentially CSR-funded investments. More specifically, analysis shows that individuals that are closest to the mines (i.e., within 0–20 km) have experienced more significant improvements especially in terms of housing conditions, assets owned and WASH relatively to those beyond the 20km radius.

The remainder of this chapter is structured as follows. Section 4.2 provides a background of the six largest mines in operation in Madagascar. Section 4.3 briefly discusses the literature on the impacts of LSM in Madagascar at the regional level. Section 4.4 presents the methods and methodology and outlines the data. Section 4.5 reports the results, while Section 4.6 concludes and provides policy implications.

4.2 Background: key characteristics of the six largest mines

Before examining the insights, the existing literature provides on meso economic and social impacts of LSM, this section aims to highlight some of the key characteristics of the six large-scale mines currently in operation in Madagascar and the differences between the six regions where they are located.

Until the 2000s, chromite was the only commodity exploited industrially in Madagascar by a state-owned company renamed Kraoma[11] but its operating scale remained

[11] Chromite production commenced in 1968 with the COMINA company, which was nationalised in 1975 and is now known as Kraomita Malagasy or Kraoma SA (World Bank 2015b). The extraction has stopped since 2018 (l'Express de Madagascar 2020)

relatively small. LSM took off at the end of 2008 with QIT Minerals Madagascar (QMM) run by the multinational firm Rio Tinto (World Bank 2015b). Since then, four other large-scale mines started extracting minerals (Chambre des mines Madagascar 2014): Ambatovy (2013, nickel/cobalt), Etablissement Gallois[12] (2016, graphite), BlackEarth Minerals (ex-Mada-Aust, 2012, granite), Mainland Mining Ltd (2010, ilmenite). These six mines are spread out throughout the country as shown in Map 2.

Map 2: The six large-scale mines selected for the study and regions in Madagascar

Only QMM abides by the Convention d'Etablissement à l'Etat Malgache. The other projects over 50 milliards Ariary (13,285,505 USD) are governed by the Loi sur les

[12] The mining operation was created in 1901 by the Gallois family. In 2016, the mine was taken over by a new operator who made significant investments to replace outdated production equipment with the most advanced technology. Annual production increased from less than 5,000 tons to 60,000 tons in 2017 (Etablissements Gallois 2021).

Grandes Investissements Miniers (LGIM) (Chambre des mines Madagascar 2014, Crawford & Nikièma 2015).

In terms of mining revenues this legally means that:

- 60% goes to mining communes (towns)
- 30% goes to mining regions
- 10% goes to a national equalisation fund.

For the purpose of this chapter, LSM designates any mine producing between 5,000 to more than 275,600 tonnes per year between 2008 and 2016.

For the six regions where the large-scale mines selected lie, there are differences and similarities. Indeed, Madagascar is known for being a *"land of contrast"* (Randrianaly et al. 2016). Most of its regions have wide disparities between one another in terms of size, proximity to the coastline, leading ethnic groups, and dialects. It's only economically that they present similarities with much of their labour force working in subsistence farming (e.g., rice, manioc), fishing, craft making and reselling the produces made from available natural resources (e.g., wood, coal).

More specifically, the characteristics of the six regions with operating large-scale mines are presented in Appendix 4.2 Atsimo-Andrefana (BlackEarth mine) is the largest region of the six regions (66,236 km^2) and the most populated in 2018 (1,799,088 inhabitants). In contrast, Analanjirofo (Mainland Mining Ltd) is the smallest region at only 21,930 km^2 and the least populated is Betsiboka (Kraoma) with 394,561 inhabitants. Most of the regions have a coastline (Anosy, Atsimo-Andrefana, Atsinanana, Analanjirofo) while two of them are landlocked (Alaotra Mangoro and Betsiboka). As a result, their climates and exposure to devastating cyclones vary. The three regions along the eastern coast of the country are particularly prone to such

natural disasters. In the past 20 years, 25 cyclones out of the 37 that struck Madagascar hit the east coast, damaging houses, crops and infrastructure as well as killing people (Rambel et al. 2019). Recovering from these losses is challenging. Most people impacted don't have insurance to claim on damage that is done to crops, goods or livestock (Randrianalijaona 2018). Those in the informal sector represent 92% of the national workforce (INSTAT 2013b) and do not receive any income support (Randrianalijaona 2018).

Another disparity among these mining regions is that each of them is inhabited by one of the 18 ethnic groups of the country: the Antanosy in Anosy, the Mahafaly in Atsimo-Andrefana, the Betsimisiraka in Analanjirofo and Atsinanana, the Bezanozano in Aloatra Mangoro, and finally the Merina in Betsiboka (Tofanelli et al. 2009). The acknowledgment of these different tribes is important in Madagascar. There are fundamental differences in their customs such as burials (Graeber 1995), physical traits (Tofanelli et al. 2009), and degree of trust and engagement with the central government based on historical reasons (Razafindrakoto, Roubaud & Wachsberger 2020). The degree and impact of ethnic fragmentation on economic growth are being relativised by recent studies (Posner 2004, Razafindrakoto, Roubaud & Wachsberger 2020) in comparison to the theory of *"African growth tragedy"* developed by Easterly and Levine (1997) where these ethnic divisions are outlined as a main cause for the slower development in Africa. As for the proportion of migrants out of the regional population, they run from 32.2% in Anosy to 62.0% in Betsiboka with a national average (excluding Analamanga) of 48.6%. Most migration is intra-regional, as indicated by the Multiple Indicator Cluster Surveys (MICS) in 2018 (INSTAT 2019). Finally, in terms of HDI, the differences in 2016 relatively to the average of non-mining regions vary from –10% (Anosy with 0.49) to +6% (Analanjirofo with 0.53).

The heterogeneity of these regions ensures that the effects of mining are examined on a non-homogeneous sample of regions, similar to the diversity across the non-mining regions. After more than 15 years of mining operations, what can be said about the economic and social impacts at the meso level? The existing literature offers some insights, despite its scarcity.

4.3 Literature review of the impacts of LSM in Madagascar at the regional level

The literature on the impacts of LSM on mining countries is mostly at the national level (see Chapter 2). While recent years have seen an increase in studies exploring local-level impacts, studies exploring regional or meso impacts remain relatively understudied, especially for Madagascar.

A few references point to potential benefits and risks of LSM at the meso level such as the mandatory Environmental Assessments (Dynatec 2006, TECSULT 2013) and Sarrasin's article on the political economy of mining development (2006a). Another academic article (Bidaud et al. 2017 p.5) concerned with the social impacts of biodiversity offsets in Madagascar conducts interviews with regional stakeholders but *"do not include detailed results from these interviews in this paper, they provided valuable context and understanding which informed the design of other components of the research".* Annual regional monographies (Alaotro-Mangoro for Ambatovy, Analanjirofo for Mainland Mining Ltd, Anosy for QMM, Atsimo-Andrefana for BlackEarth, Atsinanana for Etablissements gallois, Betsiboka for Kraoma Malagasy), contain important information such as the number of people employed in these mines, the amount of mining revenues received at the regional level or the main sources of conflicts between the mining companies and the regional population. Although these monographies are very valuable, their content and availability vary greatly from one

region to another, and from one report to the next. Also, they do not offer robust analysis of the economic and social impacts, unlike the reports produced by the Independent International Assessment Panel (IIAP) for Fort Dauphin and the Anosy region where the QMM mine lies.

The IIAP was created in 1998 and produced several publicly available reports. They reveal that, post construction boom, community perceptions of QMM were not very positive. Employment opportunities had suddenly dropped, mining royalties had not been paid yet and spillover effects were limited. In addition, the mine was reproached to not being sufficiently transparent about the allocation of its payments, poor information dissemination and benefits were seen as lacking. This “bust” situation was also during one of the most severe political crises the country ever went through and international donors had stopped giving financial aid to the country (IIAP 2011). As a consequence, when aid started to flow again and the political transition period came to an end in 2014, some improvements were noted in the 2014 report. Yet, the report highlights the lack of cohesion at the regional level as a key impediment to regional development supported by the mining activities (IIAP 2014). Things continued to improve economically with the Ehola Port becoming operational and mining royalties paid, but remained limited with the pause in the construction of regional roads that were meant to *“open Anosy to the rest of country”* (IIAP 2017). It’s only in the 2019 report that the impacts of QMM on regional development are clearly documented. This report outlines that most regional towns do not use a participatory budgeting process and as a consequence those receiving mining royalties tend to use them to fund general operations rather than investments. Given the importance of regional development, a regional development community team was formed within QMM and

international donors started funding two key regional roads on the east coast and west of Fort Dauphin.

Despite being the most reliable source of information, it is worth noting that the IIAP reports used to be funded by international aid but since 2017, by QMM itself. In addition, the Panel members are current or former members of government, the World Bank, or major businesses. Finally, the voices of regional populations are only represented through their administrative representatives or some NGOs.

Thus, the literature on the impacts of LSM at regional level is extremely limited beyond Anosy and there is a lack of independent and objective research available. This motivates this chapter to explore the meso impacts of LSM using a large sample of secondary data and collecting primary qualitative data with key mining stakeholders.

4.4 Methods and methodology

This chapter aims to explore how the benefits from the mining sector are captured by communities and measures the magnitude of the impact of mining at a meso level – that is, in mining districts versus non-mining districts and by distance to the mine (20 to 60 km). This is examined through two main channels: market (direct and indirect employment) and fiscal (investments and fiscal revenues from mining). The analysis is done using geo-localised secondary data from the DHS for 2008–2009 “before mining” and the MIS for 2016 “after mining” for the six large-scale mines currently in activity in Madagascar. The DHS and MIS are considered as comparable since they use the same questionnaires and sampling strategy (DHS 2021). The detail of the number of sampling clusters and individuals by districts are presented in the subsequent Methodology section (4.4.2). The 2016 MIS is the most recent as of July 2021. While more mines are in operation but for the purpose of this study, only six of

them have a production superior to 5,000 tonnes per year. The production per year alongside with other key characteristics of these six mines are presented in Appendix 4.2. The findings from the econometric analysis are augmented with insights from interviews with a diverse range of regional mining stakeholders.

4.4.1 Research methods

Conceptual framework

The conceptual framework used in this research question will be adapted from the one used in the World Bank's report *Are African mining communities better off?* (Chuhan-Pole, Dabalen & Land 2017) based on Aragon and Rud's work (2013). Figure 19 below describes the four main channels through which LSM impacts regional communities. This study focuses on the market and fiscal channels to assess the economic and social impact, rather than the environmental channels that have been more explored in the literature.

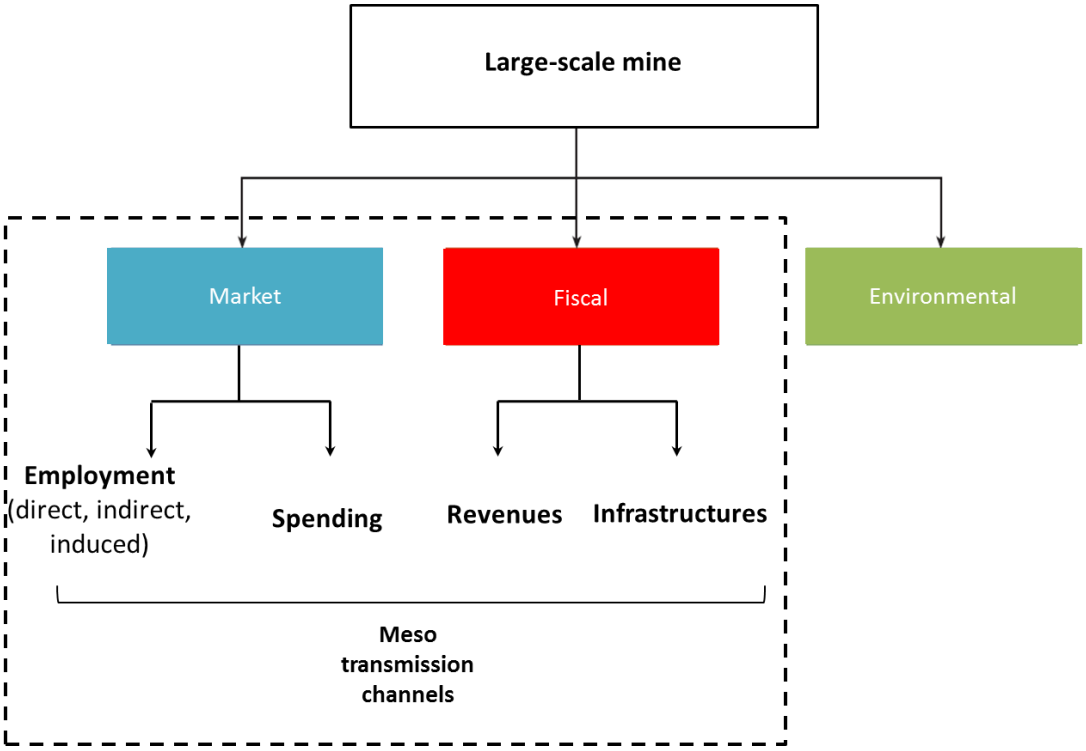


Figure 19: Selected channels of impact of LSM at the meso level

Source: Author, based on Chuhan-Pole, Dabalen and Land (2017) and Aragon and Rud's work (2013)

Mixed methods

Similarly to RQ1, RQ2 is addressed using mixed methods. More specifically, meso-economic and statistical analysis, econometric analysis and semi-structured interviews.

4.4.2 Methodology at meso, regional and district level

Since we're using the Demographic and Health Surveys (DHS) as well as Malaria Indicators Surveys (MIS), we need to use the Difference-in-Difference (DiD) surveys. Indeed, the DHS and MIS are not longitudinal studies. Thus, they so do not track the evolution of indicators for a given set of individuals. Each time the surveys are conducted, they are collected with different individuals (unless accidental renewed participation). Therefore, they are repeated cross-sections. This is why the model of

the DiD is applied here using a district panel, enabling the comparison between districts with and without mines, before and after the mines started producing.

Assumption of parallel trends

The assumption of parallel trends is fundamental for the DiD methodology. In the context of this chapter, the assumption can be interpreted as the socio-economic outcomes of interest in mining areas a following the same trend than non-mining areas prior to the mine. One way of asserting the validity of this assumption is to analyse pre-mining trends. Given that there is no localised data with GPS coordinates for Madagascar, this assumption will be explored using regional data. The assumption allows for differences in levels between the control and treatment groups, as long as the outcome variables are evolving on similar paths (Chuhan-Pole, Dabalen & Land 2017). To examine the parallel trends of mining and non-mining areas, the HDI and night lights by region were chosen. The rationale is that a region with greater economic activity has brighter lights at night. At subnational level, night light data was only available from 2005 to 2013 for Madagascar (Datainspace 2018) and HDI from 2005 to 2016. As a result, the analysis is limited to 2 years before and after mine opening. Findings are presented in figures 20 and 21. Given the strong discrepancies between the capital and the rest of the country in terms of access to health care, education and electricity, the region where the capital lies – Analamanga – is omitted. The figures enable us to confirm the assumption of parallel trends for mining and non-mining regions. In 2008, six provinces were divided into 22 regions and the historical HDIs were recalculated accordingly. This explains the sharp increase for all regions between Year-2 before opening and Year-1 on Figure 20.

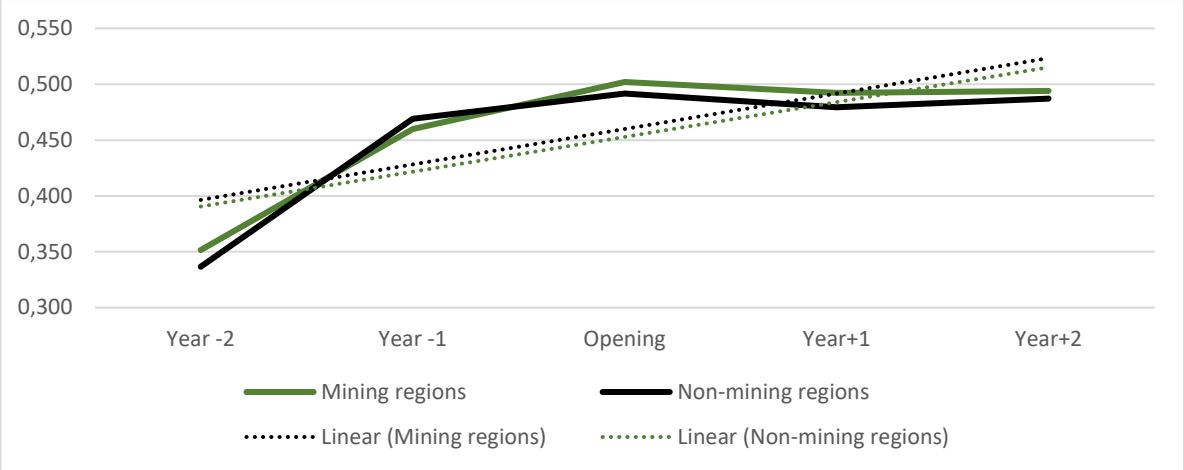


Figure 20: Average HDI by region before and after mine opening

Source: UNDP

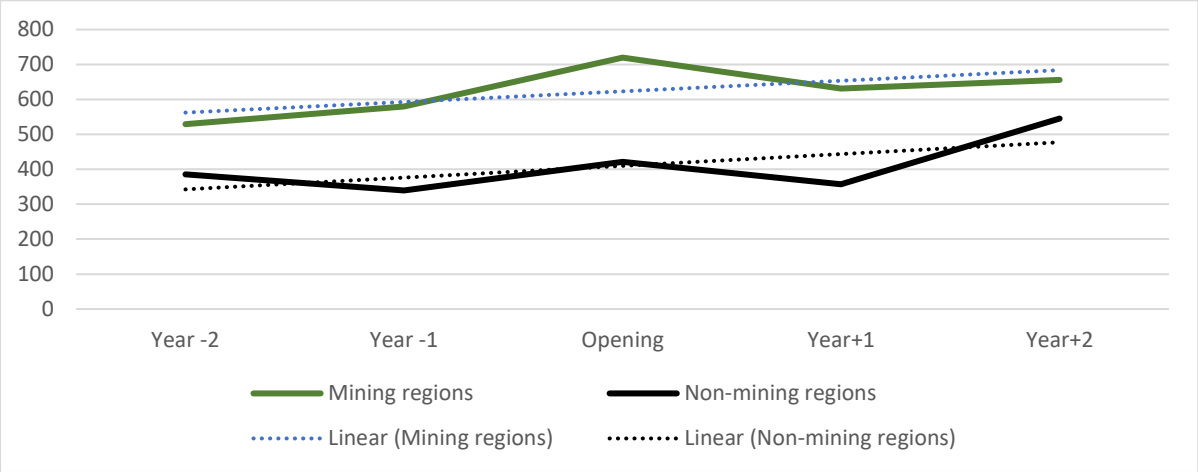


Figure 21: Average night lights by region before and after mine opening (value of light pixels sum_light)

Source: Regional Development Indicators (RDI) – Africa Version 0.1

Assessing impacts of LSM at district level

Following the approach implemented by Chuhan-Pole, Dabalen and Land (2017), this chapter examines the impacts of LSM at the district level - the second largest administrative division in Madagascar (the smallest administrative division is called fokontany and the impacts at this level are studied in Chapter 6). This enables the study to tease out whether an administrative entity matters more than distance to the

mines in terms of impacts of LSM. Map 3 below shows the six mining districts included in the analysis.

Map 3: Large-scale mines selected and mining districts

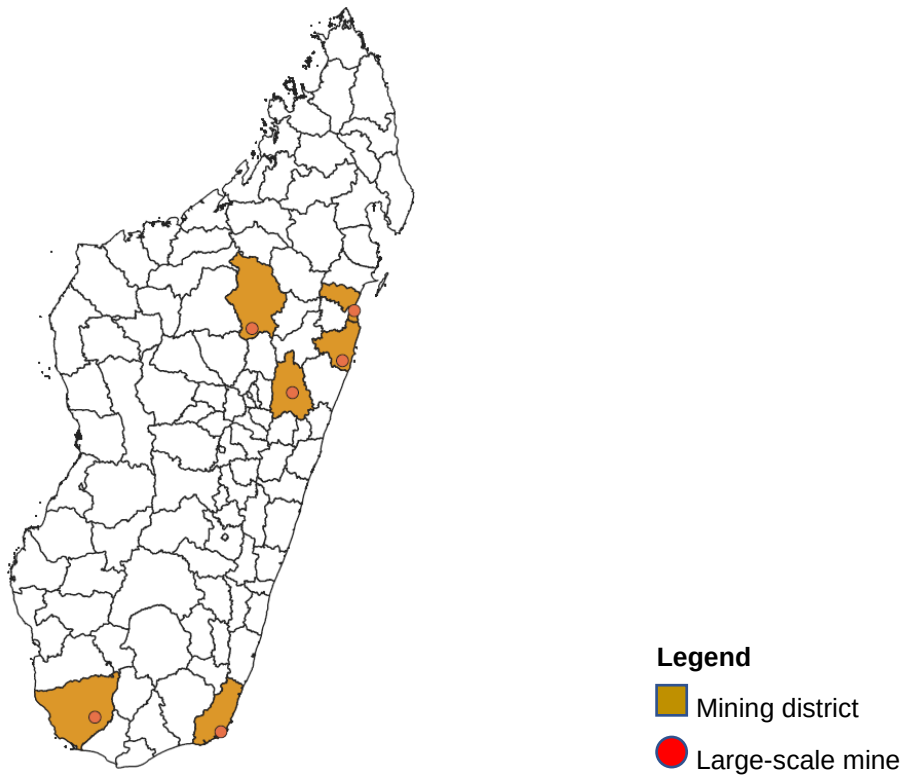


Table 11 presents the number of clusters and individuals in the six mining districts selected for the “before” and “after” survey, as well as those included in non-mining districts.

Table 11: Number of clusters and individuals in the six mining districts selected

6 mining districts	DHS 2008–2009	MIS 2016
Number of clusters in mining districts	45	39
Number of individuals in mining districts	6,483	5,398
Number of individuals in non-mining districts	78,875	43,743
Total number of individuals in sample	**85,358**	**49,141**

The objective in this section is to estimate the differences in outcomes for individuals in mining districts (Md) relative to non-mining districts (Nd) between 2008–2009 and 2016 as described in Table 12.

Table 12: Difference-in-Difference model for mining districts

Y_{dth}	2009	2016	Difference
Mining districts (Md = 1)	$Y_{Md2009i}$	$Y_{Md2016i}$	$Y_{Md2009i} - Y_{Md2016i}$
Non-mining districts (Nd = 1)	$Y_{Nd2009i}$	$Y_{Nd2016i}$	$Y_{Nd2009i} - Y_{Nd2016i}$
Difference-in-Difference			$(\boldsymbol{Y_{Md2009i} - Y_{Md2016i}}) - (\boldsymbol{Y_{Nd2009i} - Y_{Nd2016hi}})$

The following Difference-in-Difference model (4.1) is specified and estimated:

$$Y_{dt} = \alpha + \beta Year2016 + \gamma MiningDistrict_t + \delta(Year2016 * MiningDistrict_t) + \lambda X_{dt} + \varepsilon_{dt} \quad \textbf{(4.1)}$$

Where:

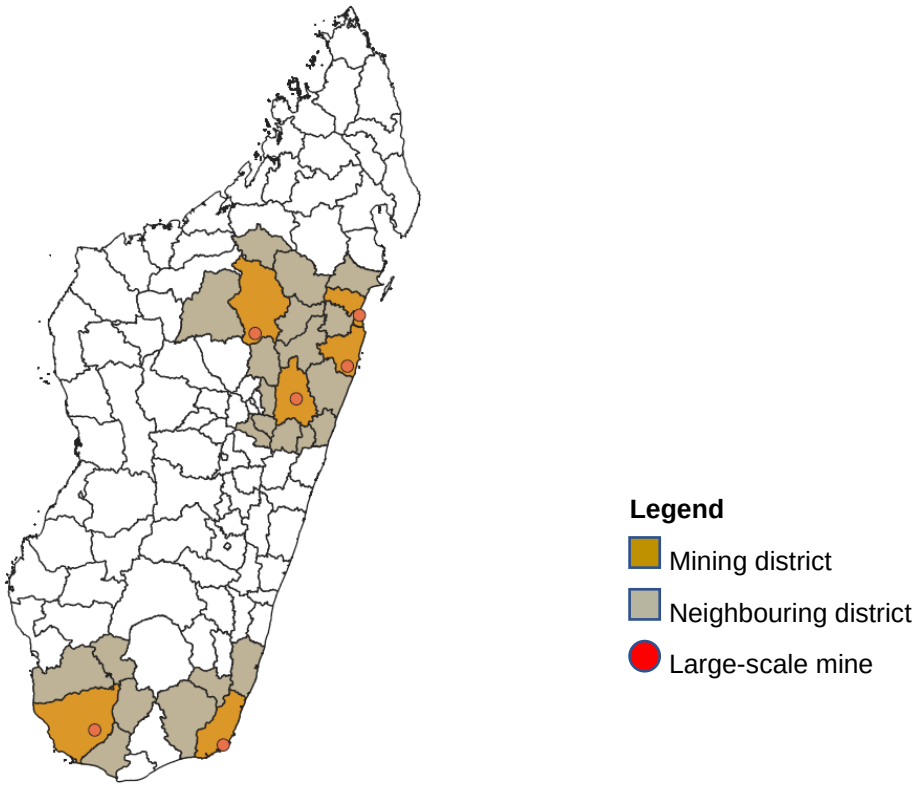
- Y_{dt} is the outcome for household *h* in district *d* at time *t* (e.g., wealth index, asset ownership)
- $Year2016$ is a dummy variable that takes 1 if year = 2016
- MiningDistrict is a dummy variable that takes 1 if a large-scale mine is located in the district
- The interaction term variable $Year2016 * MiningDistrict_t$ is also a dummy variable that takes 1 if $Year2016 = MiningDistrict_t = 1$
- $X_{h,d,t}$ is a set of control variables representing the characteristics of household *h* in district *d* in time period *t*
- ε_{dt} is the error term

The DiD method addresses endogeneity and other changes that may have impacted the communities by including both years (i.e., before and after the arrival of large-scale mines) and locations (i.e., within mining districts and outside them). Average differences between the treatment group (households living in a mining district) and the control group (households not living in a mining district) can be determined. Thus, this approach isolates the effect of LSM. The sign, size and the significance of the coefficient of the interaction term for each outcome are the focus of this study. The results are presented in Table 17. The detailed results of the regressions with control variables can be found in Appendix 4.4.

Assessing spillover effects at district level

Mining-district impacts can also spillover to a neighbouring district; for instance, if the large-scale mine invests in infrastructures accessible by those living beyond the mining districts or pays mining revenues (fiscal channel), and if the mining company generates direct or indirect employment in neighbouring mining districts (market channel). For example, in the neighbouring districts in the regions of Alaotra Mangoro and Atsinanana part of the national road between Ambatovy and the Port of Toamasina has been rehabilitated (World Bank Group 2015). Thus, in this section the neighbouring districts of mining districts will be added to the analysis. Map 4 presents the six mines, and their mining and neighbouring districts.

Map 4: Large-scale mines, mining and neighbouring districts



Similarly to Table 12, Table 13 presents the number of clusters and individuals in the 22 neighbouring districts selected for the “before” and “after” survey, as well as the total number of individuals included in non-mining districts.

Table 13: Number of clusters and individuals in the 22 neighbouring districts selected

22 neighbouring districts	DHS 2008–2009	MIS 2016
Number of clusters in neighbouring districts	90	68
Number of individuals in in neighbouring districts	13,281	9,277
Number of individuals in non-mining or neighbouring districts	72,077	39,864
Total individuals in sample in non-mining or neighbouring districts	**85,358**	**49,141**

Here the objective is to estimate the differences as described below for individuals i in neighbouring mining districts (NHd) relative to non-mining districts (Nd) between 2008–2009 and 2016.

Table 14: Difference-in-Difference model for neighbouring districts

Y_{dth}	2009[13]	2016	Difference
Neighbouring mining districts (NHd = 1)	$Y_{NHd2009i}$	$Y_{NHd2016i}$	$Y_{NHd2009i} - Y_{NHd2016i}$
Non-neighbouring or mining districts (Nd = 1)	$Y_{Nd2009i}$	$Y_{Nd2016i}$	$Y_{Nd2009i} - Y_{Nd2016i}$
Difference-in-Difference			$(\boldsymbol{Y_{NHd2009i}} - \boldsymbol{Y_{NHd2016i}}) - (\boldsymbol{Y_{Nd2009i}} - \boldsymbol{Y_{Nd2016i}})$

To compare outcomes in neighbouring and non-mining districts, the following estimation is used:

$$Y_{dt} = \alpha + \beta Year2016 + \gamma NeighbouringDistrict_t + \delta(Year2016 * NeighbouringDistrict_t) + \lambda X_{dt} + \varepsilon_{dt} \quad \textbf{(4.2)}$$

Where:

- Y_{dt} is the outcome for individual *i* in district *d at time t*
- $Year2016$ is a dummy variable that takes 1 if year = 2016
- NeighbouringDistrict is a dummy variable that takes 1 if a large-scale mine is located in a neighbouring mining district
- The interaction term variable $Year2016 * NeighbouringDistrict_t$ is also a dummy variable that takes 1 if $Year2016 = NeighbouringDistrict_t = 1$

[13] The 2008–2009 DHS survey was collected over both years, but more surveys were collected in 2009. As a result, to simplify we decided to name the variable *2009*.

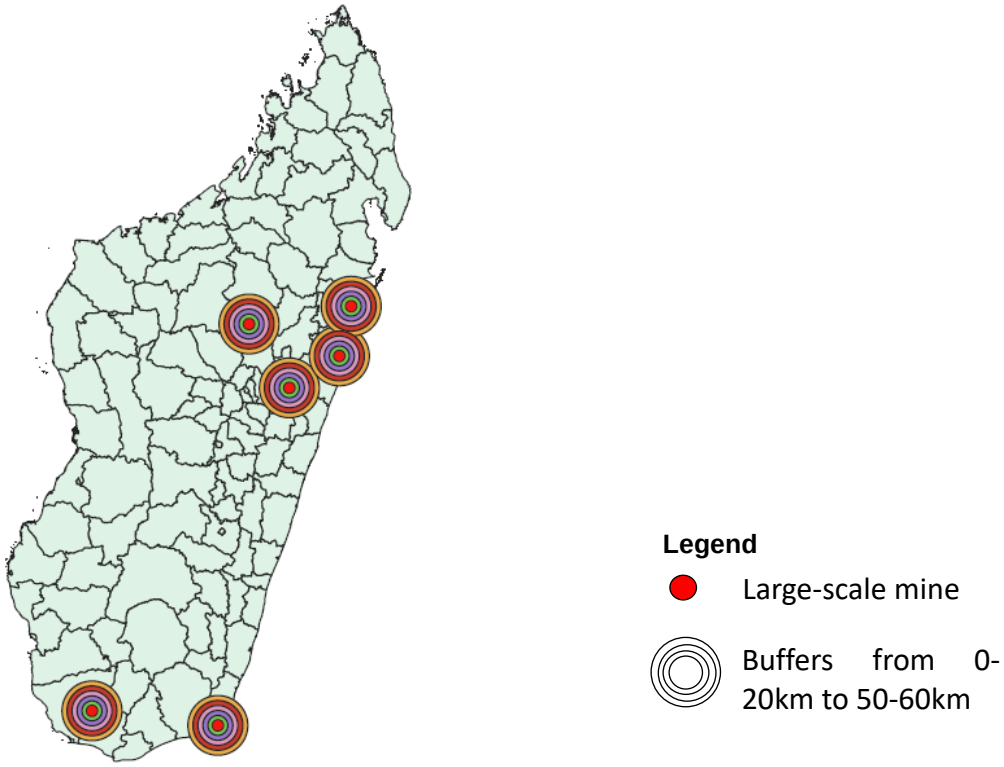
- $X_{h,d,t}$ is a set of control variables representing the characteristics of district *d* in time period *t*
- ε_{dt} is the error term

In this equation, the treatment group are households living in a mining neighbouring district and the control group are households not living in a mining neighbouring district. Similarly to Equation 4.1, using this approach enables to isolate the effect of the large-scale mines on neighbouring districts in our regressions.

Assessing the impacts by distance to the mine: 20 to 60 km

Beyond district-level effects, the economic and social impacts of LSM by distance will be studied. The main references on meso impacts of LSM explore impacts up to 100 km away from mines (Chuhan-Pole, Dabalen & Land 2017). In the case of Madagascar, given that nearly 70% of the roads in rural areas are not paved (Razafindrakoto, Roubaud & Wachsberger 2020) there is an acute lack of mobility of most people, services and goods. Thus, the maximum distance studied is fixed at 60 km in order to assess the impacts more accurately on individuals. Sixty kilometres is roughly what can be travelled over a day in Madagascar. To conduct this analysis, buffers or circles of varying distances from the mine are used. These buffers can be within a district or span several districts, depending on the mine's location. The spatial lag model divides the plane into small concentric distances, such as 20–30 km, 30–40 km and so on up to 60 km from a mine. In the regression specification, each buffer has its own coefficient, and the model thus allows for non-linear effects with distance.

Map 5: Large-scale mines and distance buffers



To compare outcomes by distance to the mines, the following estimation is used:

$$Y_{dt} = \alpha + \beta Year2016 + \gamma Minekm_t + \delta(Year2016 * Minekm_t) + \lambda X_{dt} + \varepsilon_{dt} \quad \textbf{(4.3)}$$

Where:

- Y_{dt} is the outcome for individual *i* in district *d at time t*
- $Year2016$ is a dummy variable that takes 1 if year = 2016
- $Minekm$ is a vector of dummy variables taking the value 1 if a large-scale mine is in a given distance buffer (from 0–20 km to 50–60 km)
- The interaction term variable $Year2016 * Minekm_t$ is also a dummy variable that takes 1 if $Year2016 = Minekm_t = 1$
- $X_{h,d,t}$ is a set of control variables representing the characteristics of district *d* in time period *t and* ε_{dt} is the error term

The estimate of interest is the sign, size and significance of the coefficient obtained from the interaction of $Year2016* Minekm$, which captures the average gain for the individuals who live in the vicinity of a mine compared to the average gain of those who do not live in the vicinity. A similar method was used by Aragón and Rud (2013) and Kotsadam and Tolonen (2015).

4.4.3 Data

Primary qualitative data

In total, 21 semi-structured interviews were conducted during the fieldwork with different categories of participants on the meso impacts of LSM in Madagascar as detailed in Table 15. Details on the rationale for conducting interviews with such stakeholders can be found in the Methodology section (1.3.2).

Table 15: Overview of the semi-structured interviews conducted at the meso level in Alaotro Mangoro and Anosy

Categories of mining stakeholders	Total
Representatives of mining or regional authorities	3
Subject matter experts	11
CSOs and NGOs	7
TOTAL	**21**

It must be noted that these participants were also asked about impacts at national level and for some at a local level. The fieldwork was focused on the regions of Alaotro Mangoro and Anosy, but most interviewees were able to appraise the impacts of LSM in mining regions overall.

Secondary quantitative data

In terms of secondary data at the meso level, the DHS for 2008 and the MIS for 2016 were used to capture the overall “before” and “after” mining. There was no DHS survey conducted in Madagascar post 2008–2009; the latest large-scale survey is MIS, collected in 2016. This has limited the number of outcome variables available to those used for the calculation of the wealth index (assets, housing condition, WASH etc.). Table 16 lists the dependent, explanatory and control variables selected. The wealth index was chosen as a comprehensive and standard indicator, while time to water, non-shared toilets and cemented floor are key measures of individuals’ living conditions. In addition, the ownership of some assets such as a bike, a car or truck, a radio or a bank account are also good indicators of individuals’ abilities to commute, transport goods, keep themselves up to date with announcements or entertain themselves, and to work in formal employment. In terms of control variables, three were retained as they were not included in the calculation of the wealth index: household size, cluster altitude and age of head of household. The districts near the capital of the country have been excluded from the neighbouring districts since the area concentrates most of the economic activity and would have biased the results. In the regressions, the Ordinary Least Squares (OLS, reg command in STATA) is used for continuous outcome variables (wealth index and time to water) and a probit model for binary dependent variables (non-shared toilets, bank account, cement floor, bicycle, car/truck, radio), assuming that the probability of a positive outcome is determined by the standard normal cumulative distribution function. We use a set of plausible covariates as extensive as possible based on availability to reduce omitted variables bias. This bias may yet still arise when studying outcomes that result from complex interactions among household and development factors (Saha et al. 2011).

Table 16: Summary statistics of variables used at the regional level

Variables	Unit and measurement	Obs	Mean	SD	Min	Max
Dependent variables						
Wealth index	Composite index with values from 1 to 5. It is a measure of a household's cumulative living standard. It is calculated using data on a household's ownership of selected assets; materials used for housing construction; and types of water access and sanitation facilities (Rutstein 2014).	134,999	2.9892	1.463817	1	5
Cemented floor	= 1 if the household's house had cement floor	134,999	.2132979	.4096378	0	1
Non-shared toilets	= 1 if household's house has access to toilets that are not shared with other households	73,823	.6034569	.4891829	0	1
Time to water	Time to access drinkable water, in minutes (return trip)	133,295	16.70459	42.42176	0	820
Bank account	= 1 if individual owns a bank account	134,708	.0811533	.2730714	0	1
Radio	= 1 if individual owns a radio	134,945	.5772945	.4939913	0	1
Bike	= 1 if individual owns a bike	134,946	.2200806	.4143023	0	1
Car or truck	= 1 if individual owns a car or truck	134,955	.0233115	.1508914	0	1
Explanatory variables						
Mining districts	= 1 if the individual lived in a mining district	134,999	0.0880081	0.2833077	0	1
Neighbouring districts	= 1 if the individual lived in a neighbouring district (excluding those near the capital)	134,999	0.1570826	0.36388	0	1
0–20 km	= 1 if the individual lived within 20 km of the mine	134,999	0.0226668	0.1488396	0	1
20–30 km	= 1 if the individual lived within 21 to 30 km of the mine	134,999	0.0310373	0.1734191	0	1
30–40 km	= 1 if the individual lived within 31 to 40 km of the mine	134,999	0.0173853	0.1307027	0	1
40–50 km	= 1 if the individual lived within 41 to 50 km of the mine	134,999	0.0120964	0.1093168	0	1
50–60 km	= 1 if the individual lived within 51 to 60 km of the mine	134,999	0.0198964	0.139645	0	1
Year 2016	= 1 if survey taken in 2016 (MIS)	134,999	0.3640101	0.4811533	0	1
Control variables						
Household size	Number of people living in a same household	134,999	5.882732	2.676671	1	24
Cluster altitude	Altitude of the group of households called cluster, in metre	134,999	566.1623	539.3196	0	2022
Age of head of household	Age of head of household	134,999	43.38879	14.16483	11	95

4.5 Results

4.5.1 Spillover effects exceed positive mining-district impacts

All 21 interviewees agreed on the positive impacts of LSM in the mining and neighbouring districts near Ambatovy and QMM in terms of employment created, infrastructures built, mining revenues and improved access to WASH. "*Overall improvements for the mining and neighbouring districts of the region have been considerable – and visually striking – over the years*", said a regional government official. Furthermore, most of the 21 interviewees highlighted the impacts of the waves of migration following the arrival of the large-scale mines. *"This internal migration and its consequences on the regional population are often not accounted for due to a lack of reliable data available"* underlined an NGO employee. *"Even at a regional level, people have moved away from their residence to try to find work near the mines",* added a professor at the University of Antananarivo. *"It is the source of a lot of social conflicts with the rapid increase in people coming from other places, especially as most of them are poor and can't find work"* outlined a mining expert working for CSOs. Yet, most interviewees confirmed that the impacts at regional level remained anecdotal as there was no known dataset or study available to date. The econometric analysis of the DHS data enables further qualification of these opinions and examines impacts more specifically for each of the eight outcome variables selected.

Overall the findings from the DiD analysis offer a mixed picture in terms of economic and social impacts of LSM at the meso level. To start with, the results presented in Table 17 indicate that the wealth index has decreased in mining districts by 7.7 percentage points relative to non-mining districts, whereas neighbouring districts have experienced a 15.4 percentage point (pp) growth in wealth, also relative to non-mining

districts. Both results are presented in Column 1 and are significant at the 0.01 level. The same evolution applies for household having a house with cemented floor (–2.3 pp for mining districts; +13.1 pp for neighbouring districts) and radio ownership (–1.1 pp vs +6.5 pp). In addition, neighbouring districts have experienced a larger increase in individuals owning a bank account (+1.8 pp vs +16.9 pp), a car or a truck (+14.0 pp vs 25.8 pp). In contrast, bike ownership has decreased in both mining and neighbouring districts relative to non-mining districts, but the decrease is much greater for mining districts (–16.8 pp vs –7.1 pp). Mining districts have experienced clear improvements in terms of economic and social indicators such as the proportion of individuals who have their own toilets and do not need to share them with other individuals (+20 pp vs –20.8 pp) and the time to access water (–471 pp vs –3.9 pp). The detailed results are presented in Appendix 4.4.

Table 17: District-level effects on wealth, housing and asset ownership, estimation of equations 4.1 and 4.2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wealth index	**Bank account**	**Car or truck**	**Non-shared toilets**	**Cement floor**	**Radio**	**Bike**	**Time to water**
	OLS	PROBIT	PROBIT	PROBIT	PROBIT	PROBIT	PROBIT	OLS
Mining districts	–0.077***	0.018	0.140**	0.200***	–0.023	–0.011	–0.168***	–4.716***
	(0.027)	(0.035)	(0.059)	(0.031)	(0.027)	(0.024)	(0.028)	(0.819)
Observations	134,999	134,708	134,955	73,823	134,999	134,945	134,946	133,295
R-squared or Pseudo R2	0.076	0.0119	0.0464	0.0240	0.0032	0.0366	0.0136	0.014
Neighbouring districts	0.154***	0.169***	0.258***	–0.208***	0.131***	0.065***	–0.071***	–0.039
	(0.021)	(0.033)	(0.055)	(0.028)	(0.022)	(0.019)	(0.022)	(0.645)
Observations	134,999	134,708	134,955	73,823	134,999	134,945	134,946	133,295
R-squared or Pseudo R2	0.083	0.0173	0.0492	0.0238	0.0040	0.0397	0.0136	0.014

Notes: Standard errors in parentheses clustered at the district-level. Reported coefficients are those of the interaction variable for being in a mining district or in neighbouring districts in the survey year. Unreported coefficients include that of the treatment dummy, year dummy and the control variables. Column 1 and 8 show the results of equation 4.1 (mining districts) and 4.2 (neighbouring districts) using OLS with Wealth index and Time to water as a dependent variable. Column 2 to 7 show the results of equation 4.1 and 4.2 using PROBIT with bank account, car or truck, on-shared toilets, cement floor, radio, bike ownership respectively. ***p < 0.01, **p < 0.05, *p < 0.1.

Thus, mining districts seem to have benefited more from LSM from a WASH perspective rather than from a living condition and asset accumulation standpoint, relative to neighbouring mining districts and non-mining districts. Several factors are at play. First, local economies of neighbouring districts have been less disrupted by the arrival of the mines and have managed to maintain their activities. *"They have kept their land and continue to grow rice and manioc, farm chickens, goats and zebus for the wealthiest of them"* highlighted the deputy mayor of a commune at the border of a mining district in Anosy. Second, neighbouring districts have benefited from the infrastructure and facilities built such as ports and roads, regional economic development and some CSR-funded activities accessible to the regional population. Third, due to the *"pull effect of the mines […] poorer migrants with no or little assets and low level of education have moved to the mining districts hoping to find work"* outlined an NGO employee. Yet, as poor migrants tend to own fewer assets it further explains why overall people in mining districts have seen their livelihoods worsen in comparison to neighbouring districts. In addition, the low level of education that characterise these deprived migrants may prevent them from benefiting from LSM-related work opportunities as shown in the literature (Pokorny et al.). Finally, the inflation created by the inflow of migrants and mining workers has considerably increased the costs of living, which has also contributed to decrease the wealth index in mining districts. *"People used to survive before (the arrival of the mine). Since then, the cost of rent and basic food is too high for them"* noted a mayor in Alaotra Mangoro. Therefore, this analysis shows that LSM can have mixed blessings depending on whether people live in a mining district or a neighbouring one. It sheds light on an unknown impact of mining at this stage: without intervention, spillover effects of LSM exceed mining-district impacts in Madagascar.

4.5.2 Impacts by distance: the closer the better

There was a consensus among interviewees on the impacts by distance to the mines. *"Individuals close to the mine have more benefited from mining than those living further away",* said a mining expert working in the NGO sector. *"The mine has helped creating a regional bourgeoisie that didn't exist beforehand"* stated a researcher specialising in sustainable mining.

To test this consensus among interviewees, a binary variable is used to compare people within 20 km and up to 60 km of a mine. As described in Table 16, the distance variables (0 – 20 km, 20 – 30 km, 30 – 40 km, 40 – 50km, 50- 60 km) equal 1 if the individual lives within 0 to 20 km to one of the six large-scale mines for the 0 – 20 km variable for example, and until 60 km to a mine. A spatial lag model is used to capture the impacts, which allows for non-linear effects with distance. The results of this model are presented in Figure 22.

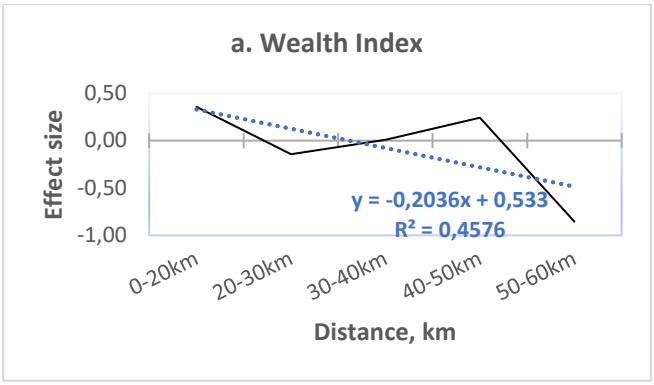
Overall, individuals that are the closest to the mines have benefited more from the mine arrivals than those further away. For example, the wealth index of individuals is significantly higher close to the large-scale mines (0–20 km +35.7 pp) but drops for those in the 20–30 km bin by 14.4 pp. This is likely to be due to direct and indirect employment opportunities, as well as improvements in living standards for those that are much closer to the mines. Unfortunately, the data doesn't allow to establish whether their source of income is linked to the mining activities as employment data are not collected in the MIS. This non-linear relationship between the wealth index and distance beyond 20 km to the mines is in line with the findings from key references from the literature (Chuhan-Pole, Dabalen & Land 2017, Kotsadan and Tolonen 2016).

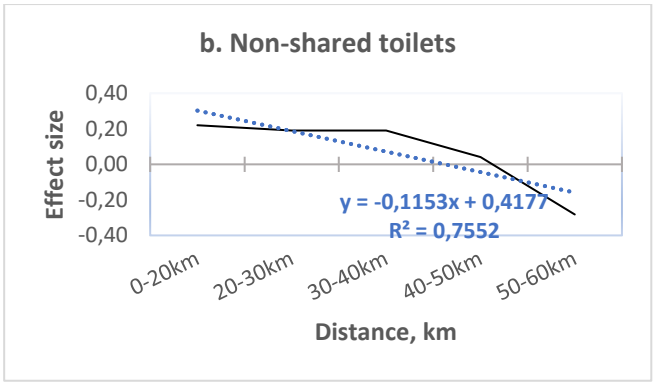
More specifically, in terms of sanitation outcomes, households near mines have significantly more non-shared toilets (0–20 km, +22pp) and experienced a reduction in their time to access water (–154.5pp) than the average of individuals living between 20 and 60 km. The former individuals have also experienced a significant increase in owning a bank account (+16.9pp), living in a house with cemented floor (+41.6pp), and owning a radio (+36.6pp) or a car or truck (+43.4pp). Thus, all outcome variables have improved more for individuals in the 0 to 20 km-radius, except for ownership of a bike. It is worth noting that trendlines confirm that individuals between 20 and 60 km have not benefited as much as those in the 0 to 20 km radii. Indeed, their coefficients are all negative, except for time to water, which means that the further away individuals live from a mine, the longer it takes them to access drinking water.

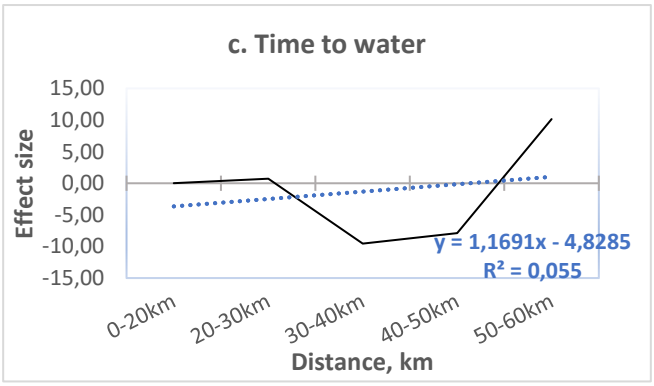
Interviewees explained that these better outcomes for those living within 20 km to the mines relatively to those living further away within a same district were the result of three main factors. Firstly, people within 20 km of the mines were more likely to benefit from direct, indirect or induced work opportunities rather than those living further away in a country where the roads are in poor condition preventing those further away from accessing the same opportunities. In addition, these work opportunities tend to be in non-agricultural sector and characterised with higher wages, as shown in the literature (Chuhan-Pole, Dabalen & Land 2017). *"With the arrival of the mine, people here have tried to offer services and provide goods that those who live beyond 20 km find it hard to do since it may take them a whole day to travel closer to the mine given the roads conditions"* highlighted a local academic. Secondly, investments in Water Sanitation and Hygiene (WASH) programmes were prioritised within 20 km to the mines and partly funded by Corporate Social Responsibility (CSR) activities as part of their contribution to the Sustainable Development Goal 6. Thirdly, communes (towns)

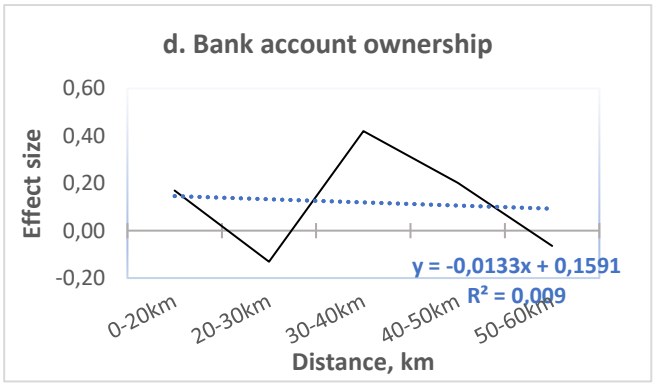
closer to the mines are more likely *"to receive mining revenues much faster than regions due to the administrative complexities"*, according to a mining and legal expert.

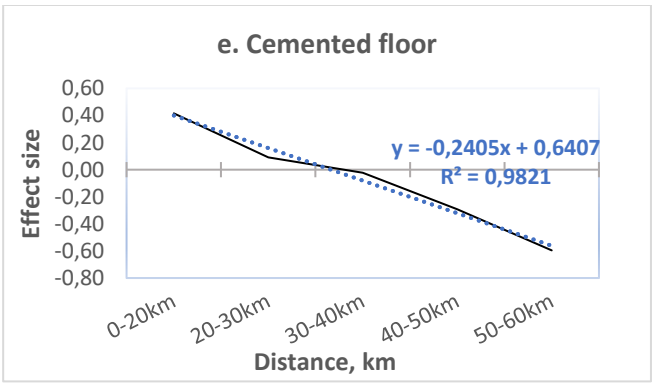
Therefore, these findings support what interviewees had anecdotally observed: *"before QMM there was nothing modern, not even roads […] it looked like in a Western town. The region has benefited from mining, but disparities remain"* stated a CSO employee in Anosy.

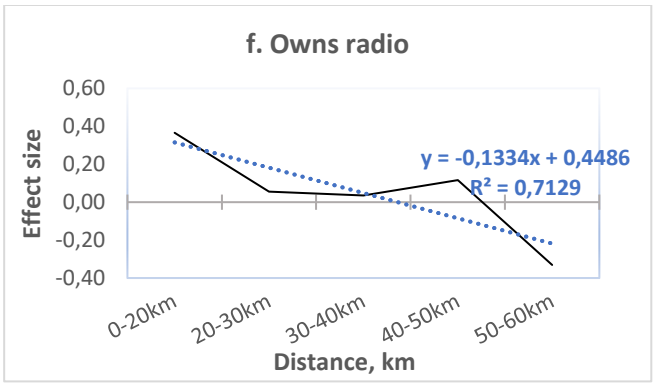


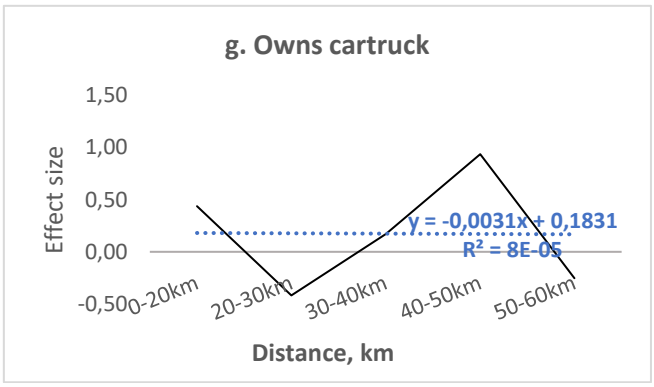












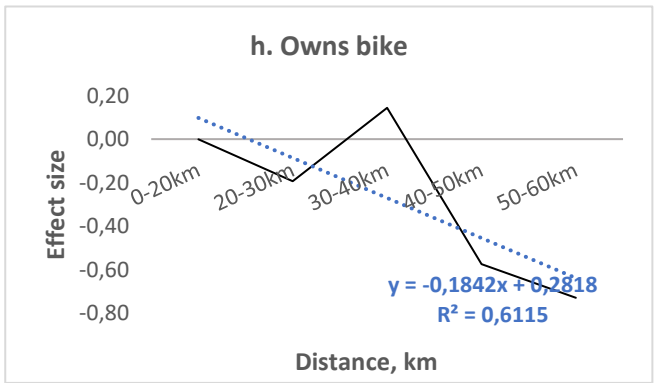


Figure 22: Spatial lag model illustrating geographic distribution of effects on wealth outcome, house condition and asset ownership

Source : Author's estimates, DHS 2008-09, MIS 2016

4.6 Conclusion

The impacts of LSM at the meso level are heterogenous and a mixed blessing depending on where individuals live and the type of outcomes; that is, living standards (wealth index), housing characteristics, WASH and asset ownership. Our findings show that there seems to be thresholds for individuals to benefit from mining. Those who are close to the mine, up to 20 km, have benefited more compared to those who live further away for whom most outcomes have dropped since the mine arrivals. This is mainly due to the access to employment opportunities (direct, indirect through procurement or induced by spending), new infrastructure built (e.g., roads, ports, WASH). More specifically, up to 60 km, impacts are overall negative. However, beyond this threshold of 70 km, which roughly corresponds to the size of districts in Madagascar,[14] impacts appear to be more positive, with neighbouring districts reporting better outcomes than mining districts, especially in terms of living conditions and asset accumulation. This positive outcome for neighbouring mining districts results from less disruption of productive activities, as well as access to some of the large infrastructures built such as ports and roads; whilst mining districts have experienced a rise in inflation due to the mining boom and a pull effect on the most deprived migrants. With limited assets owned and a low level of education, the latter tend to struggle to fend for themselves and lower the overall wealth index of mining districts.

These findings could be used to inform future regional and national development plans and guide the strategy of LSM in terms of economic and social development at the meso level. It could also enable the prioritisation of areas of focus for investments of mining revenues or inform the identification of development targets by regional and

[14] Author's calculations based on the average size of the 114 districts in Madagascar.

national governments that would be monitored by the civil society to ensure benefits are more equally shared. For example, incentive programs could be implemented to slow migration to the mining districts for the most impoverished. Specific support to households in 20 to 60 km of a mine could be provided, especially in terms of WASH.

Although these findings contribute to the understanding of the differentiated impacts between national and regional levels, they do not distinguish how households and individuals within these radii have been impacted by the large-scale mines. This is particularly important in a country with limited roads and transportation infrastructure (Razafindrakoto, Roubaud & Wachsberger 2020). Furthermore, a large proportion of the population are dependent on subsistence farming to survive and therefore any disruption to their livelihoods with potential land acquisition or pollution for example could have acute effects on their economic and social situation (Aragón and Rud 2016). This motivates the next chapter which focuses on the local impacts of LSM for communities within 20 km of Ambatovy and QMM.

Appendix 4.1: Key characteristics of the six large-scale mines studied

Mine name	Site	Minerals	Region	District	Production volume (up to in tonnes)	Value (USD)	Ownership
Ambatovy	Ambatovy	Nickel, cobalt, ammonium sulphate	Alaotro-Mangoro	Moramanga	275,600	114.2	Canada, Japan, South Korea
Etablissements gallois	Antsirakambo	Graphite	Atsinanana	Toamasina II	10,000	2	Macau, China
Kraoma SA	Andriamena	Chrome	Betsiboka	Tsaratanàna	150,000	Not available	Madagascar
BlackEarth	Ampanihy	Graphite	Atsimo-Andrefana	Ampanihy	60,000	Not available	Australia
Mainland Mining Ltd	Fenoarivo Atsinanana	Ilmenite, zircon	Analanjirofo	Fenoarivo Atsinanana	38,500	Not available	China
QMM	Fort Dauphin	Ilmenite	Anosy	Taolagnaro	50,200	42.3	UK/Australia, Madagascar

Sources: Companies' websites, EITI 2015

Appendix 4.2: Comparison of key statistics per mining region

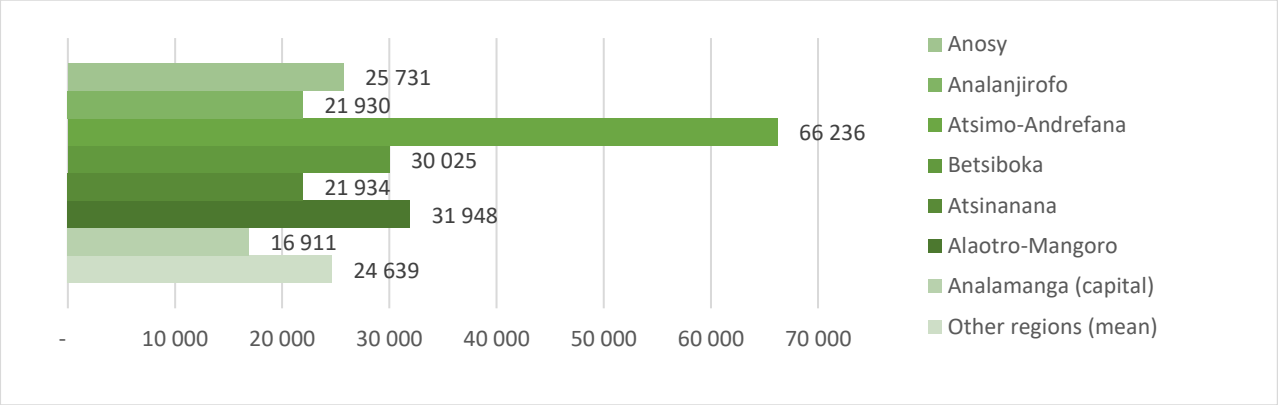


Figure 23: Comparison of region size (km^2)

Source: INSTAT 2020a

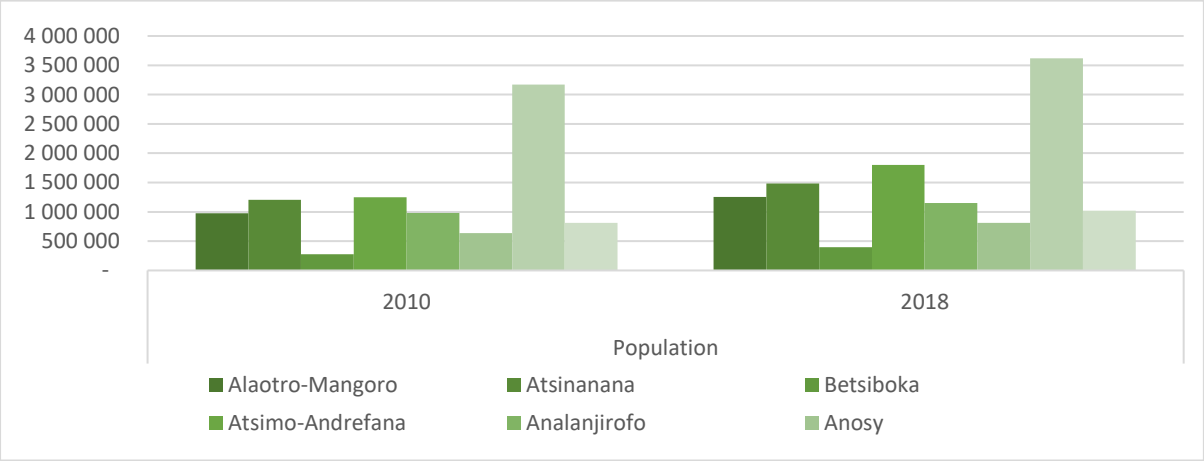


Figure 24: Comparison of population size by region

Source: INSTAT 2020a

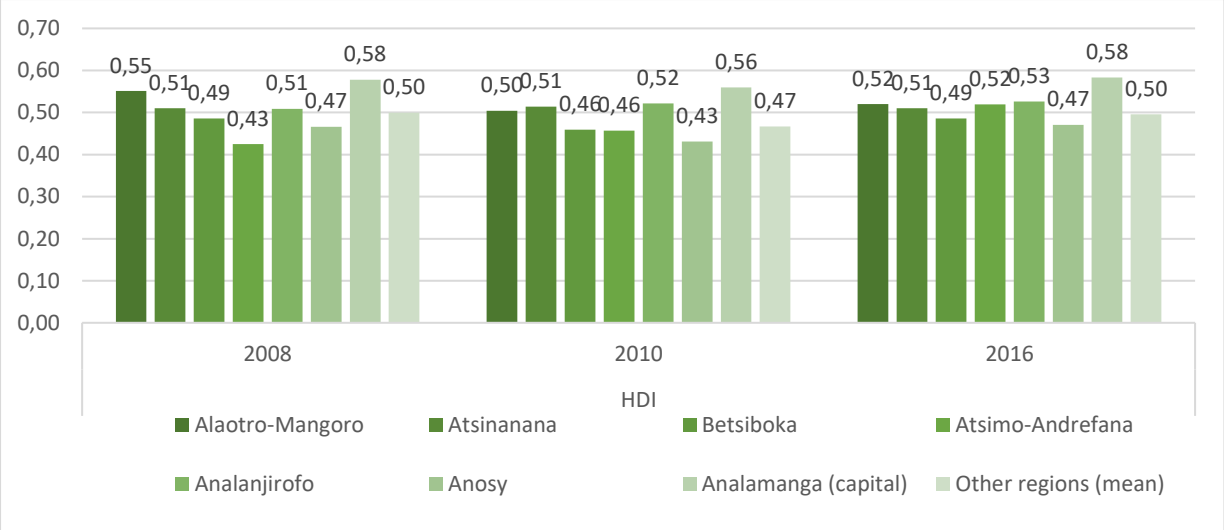


Figure 25: Comparison of regional HDI

Source: UNDP 2019

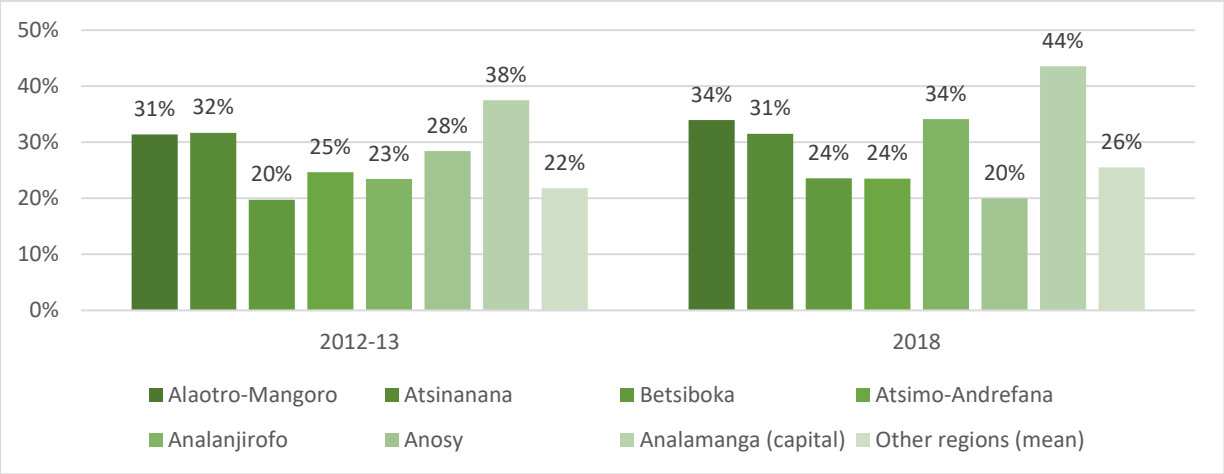


Figure 26: Comparison of secondary level of education for women (%)

Source: UNDP 2019

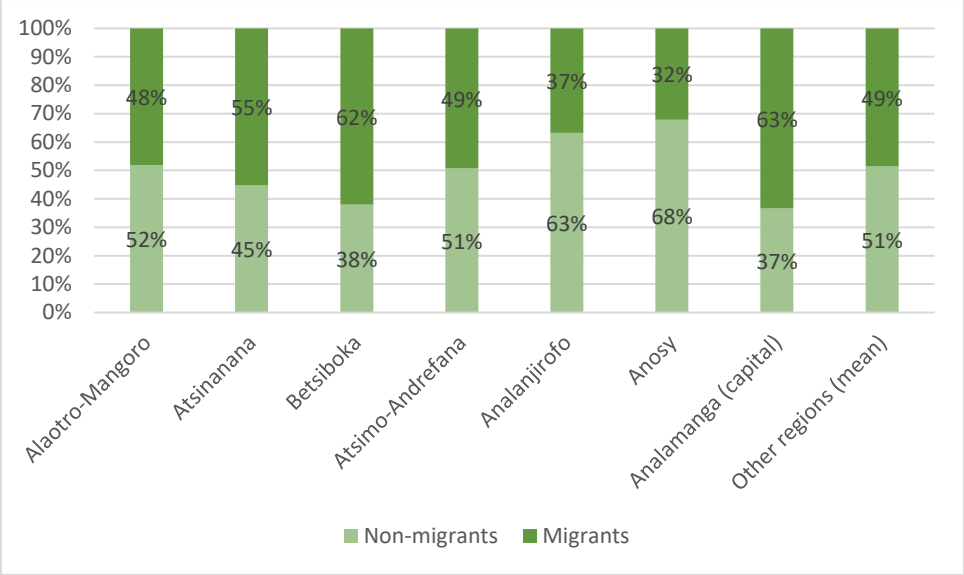
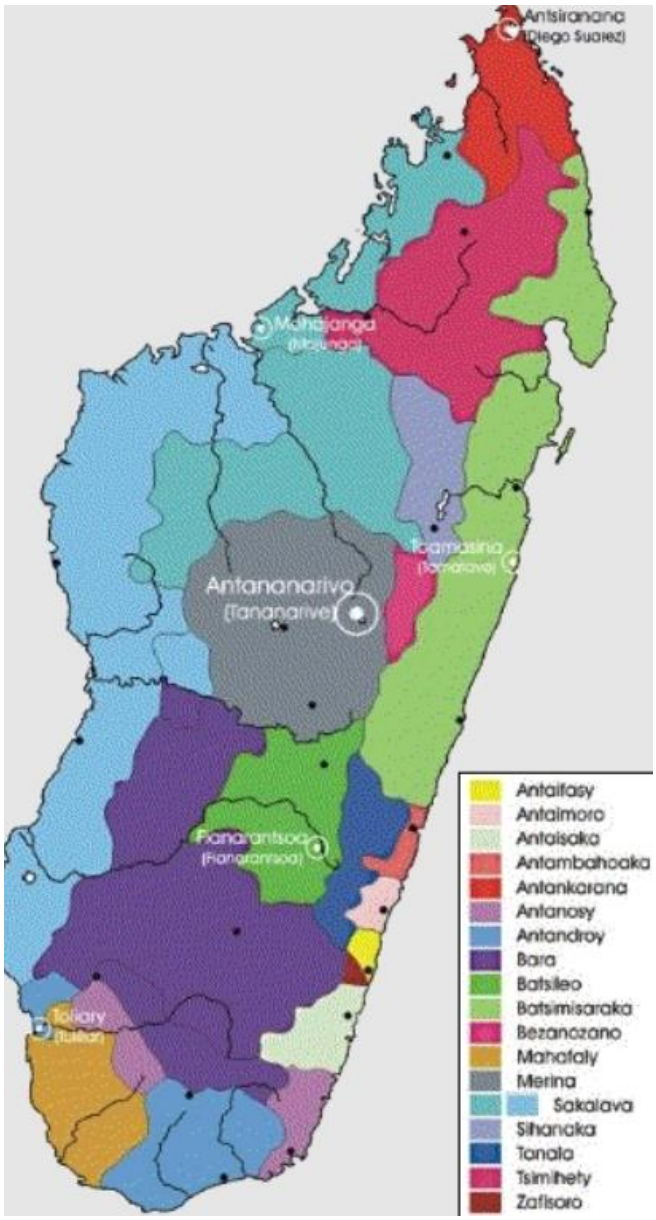


Figure 27: Comparison of proportion of migrants by region in 2018 (%)

Sources: INSTAT, UNDP, MICS 2018

Appendix 4.3: Ethnic groups in Madagascar

Map 6: Presence of 18 ethnic groups in Madagascar



Source: Mobot 2021

Appendix 4.4: Results of regressions with equations 4.1 to 4.3

Table 18: Results of DiD model with dependent variable Wealth Index (WI)

Dependent variable: Wealth Index	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	0.095***										
	(0.018)										
Year 2016	0.015*	-0.006	-0.010	0.012	0.018**	0.006	0.028***	0.009	-0.006	0.149***	-0.015*
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Year 2016*Mining districts	-0.077***										
	(0.027)										
Neighbouring districts		-0.407***									
		(0.014)									
Year 2016*Neighbouring districts		0.154***									
		(0.021)									
0–20 km radius			0.685***								
			(0.037)								
Year 2016*0-20km radius			0.357***								
			(0.051)								
20–30 km radius				0.668***							
				(0.029)							
Year 2016*20-30km radius				-0.144***							
				(0.045)							
30–40 km radius					-0.534***						
					(0.046)						
Year 2016*30-40km radius					0.010						
					(0.060)						
40–50 km radius						-0.906***					
						(0.044)					
Year 2016*40-50km radius						0.242***					
						(0.072)					
50–60 km radius							0.172***				
							(0.036)				
Year 2016*50-60km radius							-0.854***				
							(0.056)				
60–70 km radius								-0.358***			
								(0.035)			
Year 2016*60-70km radius								0.120**			
								(0.052)			
70–80 km radius									-0.679***		
									(0.030)		
Year 2016*70-80km radius									0.609***		
									(0.047)		
80–90 km radius										1.454***	
										(0.017)	
Year 2016*80-90km radius										-1.734***	
										(0.033)	
90–100 km radius											0.198***
											(0.024)
Year 2016*90-100km radius											0.621***
											(0.041)
Household size	-0.037***	-0.036***	-0.036***	-0.037***	-0.037***	-0.038***	-0.037***	-0.037***	-0.037***	-0.028***	-0.037***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cluster altitude	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.005***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999
R-squared	0.076	0.083	0.083	0.081	0.078	0.079	0.077	0.076	0.079	0.125	0.080

Notes: Standard errors in parentheses. For all columns the dependent variable is Wealth Index in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used OLS. ***p < 0.01, **p < 0.05, *p < 0.1

Table 19: Results of DiD model with dependent variable Bank account ownership

Dependent variable: Bank account	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	0.082***										
	(0.024)										
Year 2016	0.021*	0.014	0.011	0.030***	0.030***	0.024**	0.026**	0.025**	0.012	0.201***	-0.001
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Year 2016*Mining districts	0.018										
	(0.035)										
Neighbouring districts		-0.399***									
		(0.023)									
Year 2016*Neighbouring districts		0.169***									
		(0.033)									
0–20 km radius			0.389***								
			(0.042)								
Year 2016*0-20km radius			0.169***								
			(0.056)								
20–30 km radius				0.321***							
				(0.034)							
Year 2016*20-30km radius				-0.131**							
				(0.054)							
30–40 km radius					-1.054***						
					(0.144)						
Year 2016*30-40km radius					0.420**						
					(0.164)						
40–50 km radius						-1.238***					
						(0.171)					
Year 2016*40-50km radius						0.202					
						(0.247)					
50–60 km radius							-0.259***				
							(0.054)				
Year 2016*50-60km radius							-0.064				
							(0.087)				
60–70 km radius								-0.437***			
								(0.062)			
Year 2016*60-70km radius								0.122			
								(0.086)			
70–80 km radius									-0.669***		
									(0.062)		
Year 2016*70-80km radius									0.742***		
									(0.077)		
80–90 km radius										1.169***	
										(0.018)	
Year 2016*80-90km radius										-1.145***	
										(0.042)	
90–100 km radius											0.053*
											(0.030)
Year 2016*90-100km radius											0.436***
											(0.046)
Household size	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.007***	-0.006***	-0.006***	-0.006***	0.005**	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Cluster altitude	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***	0.004***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	-1.616***	-1.542***	-1.627***	-1.624***	-1.595***	-1.592***	-1.599***	-1.597***	-1.593***	-1.714***	-1.596***

Notes: Standard errors in parentheses. For all columns the dependent variable is Bank account ownership in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used PROBIT. ***p < 0.01, **p < 0.05, *p < 0.1

Table 20: Results of DiD model with dependent variable Car or truck ownership

Dependent variable: Car or truck	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	0.005										
	(0.038)										
Year 2016	-0.212***	-0.221***	-0.217***	-0.183***	-0.198***	-0.201***	-0.195***	-0.201***	-0.203***	-0.019	-0.226***
	(0.018)	(0.019)	(0.018)	(0.018)	(0.018)	(0.017)	(0.018)	(0.018)	(0.018)	(0.019)	(0.018)
Year 2016*Mining districts	0.140**										
	(0.059)										
Neighbouring districts		-0.314***									
		(0.035)									
Year 2016*Neighbouring districts		0.258***									
		(0.055)									
0–20 km radius			0.066								
			(0.075)								
Year 2016*0-20km radius			0.437***								
			(0.098)								
20–30 km radius				0.412***							
				(0.048)							
Year 2016*20-30km radius				-0.417***							
				(0.100)							
30–40 km radius					-4.733						
					(1,333.454)						
Year 2016*30-40km radius					4.529						
					(1,333.454)						
40–50 km radius						-1.068***					
						(0.294)					
Year 2016*40-50km radius						0.934***					
						(0.344)					
50–60 km radius							-0.106				
							(0.072)				
Year 2016*50-60km radius							-0.254				
							(0.169)				
60–70 km radius								-0.066			
								(0.073)			
Year 2016*60-70km radius								0.146			
								(0.112)			
70–80 km radius									-1.266***		
									(0.220)		
Year 2016*70-80km radius									1.022***		
									(0.243)		
80–90 km radius										0.959***	
										(0.023)	
Year 2016*80-90km radius										-0.751***	
										(0.062)	
90–100 km radius											0.163***
											(0.038)
Year 2016*90-100km radius											0.322***
											(0.063)
Household size	0.024***	0.024***	0.025***	0.023***	0.024***	0.024***	0.024***	0.024***	0.024***	0.037***	0.024***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Cluster altitude	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	0.007***	0.007***	0.007***	0.007***	0.007***	0.007***	0.007***	0.007***	0.007***	0.006***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	134,955	134,955	134,955	134,955	134,955	134,955	134,955	134,955	134,955	134,955	134,955

Notes: Standard errors in parentheses. For all columns the dependent variable is Car or truck ownership in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used PROBIT. ***p < 0.01, **p < 0.05, *p < 0.1

Table 21: Results of DiD model with dependent variable Non-shared toilets

Dependent variable: Non-shared toilets	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	-0.049**										
	(0.023)										
Year 2016	-0.019*	-0.068***	-0.035***	-0.034***	-0.041***	-0.041***	-0.054***	-0.050***	-0.044***	-0.031***	-0.050***
	(0.010)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Year 2016*Mining districts	-0.200***										
	(0.031)										
Neighbouring districts		-0.212***									
		(0.020)									
Year 2016*Neighbouring districts		0.208***									
		(0.028)									
0–20 km radius			0.108**								
			(0.042)								
Year 2016*0-20km radius			-0.220***								
			(0.054)								
20–30 km radius				-0.018							
				(0.032)							
Year 2016*20-30km radius				-0.190***							
				(0.045)							
30–40 km radius					-0.603***						
					(0.053)						
Year 2016*30-40km radius					0.245***						
					(0.066)						
40–50 km radius						-0.379***					
						(0.063)					
Year 2016*40-50km radius						-0.041					
						(0.086)					
50–60 km radius							-0.484***				
							(0.036)				
Year 2016*50-60km radius							0.282***				
							(0.061)				
60–70 km radius								-0.130***			
								(0.047)			
Year 2016*60-70km radius								0.308***			
								(0.065)			
70–80 km radius									-0.110**		
									(0.047)		
Year 2016*70-80km radius									0.095		
									(0.060)		
80–90 km radius										0.119***	
										(0.017)	
Year 2016*80-90km radius										0.026	
										(0.042)	
90–100 km radius											-0.023
											(0.027)
Year 2016*90-100km radius											0.138***
											(0.044)
Household size	-0.087***	-0.087***	-0.088***	-0.087***	-0.088***	-0.088***	-0.088***	-0.087***	-0.088***	-0.086***	-0.088***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Cluster altitude	0.000	0.000	0.000**	0.000	0.000	0.000*	0.000*	0.000**	0.000**	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	73,823	73,823	73,823	73,823	73,823	73,823	73,823	73,823	73,823	73,823	73,823

Notes: Standard errors in parentheses. For all columns the dependent variable is Non-shared toilets in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used PROBIT. ***p < 0.01, **p < 0.05, *p < 0.1

Table 22: Results of DiD model with dependent variable Cement floor

Dependent variable: Cement floor	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	-0.025										
	(0.019)										
Year 2016	0.044***	0.023***	0.026***	0.038***	0.048***	0.043***	0.052***	0.034***	0.030***	0.117***	0.024***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Year 2016*Mining districts	-0.023										
	(0.027)										
Neighbouring districts		-0.149***									
		(0.014)									
Year 2016*Neighbouring districts		0.131***									
		(0.022)									
0–20 km radius			0.019								
			(0.037)								
Year 2016*0-20km radius			0.416***								
			(0.049)								
20–30 km radius				0.078***							
				(0.029)							
Year 2016*20-30km radius				0.090**							
				(0.043)							
30–40 km radius					-0.420***						
					(0.054)						
Year 2016*30-40km radius					-0.023						
					(0.070)						
40–50 km radius						-0.631***					
						(0.058)					
Year 2016*40-50km radius						-0.291***					
						(0.104)					
50–60 km radius							0.027				
							(0.036)				
Year 2016*50-60km radius							-0.596***				
							(0.064)				
60–70 km radius								-0.282***			
								(0.039)			
Year 2016*60-70km radius								0.365***			
								(0.054)			
70–80 km radius									-0.252***		
									(0.033)		
Year 2016*70-80km radius									0.432***		
									(0.048)		
80–90 km radius										0.811***	
										(0.016)	
Year 2016*80-90km radius										-0.628***	
										(0.032)	
90–100 km radius											0.286***
											(0.022)
Year 2016*90-100km radius											0.351***
											(0.037)
Household size	-0.019***	-0.019***	-0.018***	-0.019***	-0.019***	-0.019***	-0.019***	-0.019***	-0.019***	-0.014***	-0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cluster altitude	-0.000***	-0.000***	-0.000*	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.002***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999	134,999

Notes: Standard errors in parentheses. For all columns the dependent variable is Cement floor in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used PROBIT. ***p < 0.01, **p < 0.05, *p < 0.1

Table 23: Results of DiD model with dependent variable Radio

Dependent variable: Radio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	-0.071***										
	(0.016)										
Year 2016	-0.212***	-0.220***	-0.228***	-0.218***	-0.212***	-0.217***	-0.208***	-0.215***	-0.216***	-0.167***	-0.220***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Year 2016*Mining districts	-0.011										
	(0.024)										
Neighbouring districts		-0.260***									
		(0.013)									
Year 2016*Neighbouring districts		0.065***									
		(0.019)									
0–20 km radius			0.083**								
			(0.034)								
Year 2016*0-20km radius			0.366***								
			(0.047)								
20–30 km radius				0.199***							
				(0.026)							
Year 2016*20-30km radius				0.056							
				(0.040)							
30–40 km radius					-0.285***						
					(0.041)						
Year 2016*30-40km radius					0.035						
					(0.054)						
40–50 km radius						-0.285***					
						(0.040)					
Year 2016*40-50km radius						0.116*					
						(0.065)					
50–60 km radius							-0.078**				
							(0.033)				
Year 2016*50-60km radius							-0.331***				
							(0.051)				
60–70 km radius								-0.246***			
								(0.032)			
Year 2016*60-70km radius								0.067			
								(0.047)			
70–80 km radius									-0.349***		
									(0.027)		
Year 2016*70-80km radius									0.086**		
									(0.043)		
80–90 km radius										0.559***	
										(0.018)	
Year 2016*80-90km radius										-0.728***	
										(0.032)	
90–100 km radius											-0.071***
											(0.022)
Year 2016*90-100km radius											0.109***
											(0.038)
Household size	0.024***	0.025***	0.025***	0.024***	0.024***	0.024***	0.024***	0.024***	0.024***	0.027***	0.024***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cluster altitude	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***	0.003***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	134,945	134,945	134,945	134,945	134,945	134,945	134,945	134,945	134,945	134,945	134,945

Notes: Standard errors in parentheses. For all columns the dependent variable is Radio in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used PROBIT. ***p < 0.01, **p < 0.05, *p < 0.1

Table 24: Results of DiD model with dependent variable Bike ownership

Dependent variable: Bike	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	0.086***										
	(0.018)										
Year 2016	-0.092***	-0.095***	-0.104***	-0.101***	-0.108***	-0.104***	-0.093***	-0.108***	-0.107***	-0.120***	-0.113***
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Year 2016*Mining districts	-0.168***										
	(0.028)										
Neighbouring districts		-0.003									
		(0.014)									
Year 2016*Neighbouring districts		-0.071***									
		(0.022)									
0–20 km radius			0.279***								
			(0.035)								
Year 2016*0-20km radius			-0.208***								
			(0.051)								
20–30 km radius				0.229***							
				(0.028)							
Year 2016*20-30km radius				-0.193***							
				(0.045)							
30–40 km radius					-0.175***						
					(0.049)						
Year 2016*30-40km radius					0.144**						
					(0.063)						
40–50 km radius						-0.268***					
						(0.049)					
Year 2016*40-50km radius						-0.575***					
						(0.107)					
50–60 km radius							0.245***				
							(0.034)				
Year 2016*50-60km radius							-0.730***				
							(0.064)				
60–70 km radius								0.026			
								(0.034)			
Year 2016*60-70km radius								0.025			
								(0.052)			
70–80 km radius									0.093***		
									(0.029)		
Year 2016*70-80km radius									-0.007		
									(0.047)		
80–90 km radius										-0.126***	
										(0.017)	
Year 2016*80-90km radius										0.167***	
										(0.034)	
90–100 km radius											0.155***
											(0.022)
Year 2016*90-100km radius											0.135***
											(0.039)
Household size	0.033***	0.033***	0.033***	0.033***	0.033***	0.032***	0.033***	0.033***	0.033***	0.032***	0.033***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cluster altitude	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	134,946	134,946	134,946	134,946	134,946	134,946	134,946	134,946	134,946	134,946	134,946

Notes: Standard errors in parentheses. For all columns the dependent variable is Bike ownership in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used PROBIT. ***p < 0.01, **p < 0.05, *p < 0.1

Table 25: Results of DiD model with dependent variable Time to water

Dependent variable: Time to water	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mining districts	0.181										
	(0.550)										
Year 2016	1.425***	0.867***	1.067***	0.937***	1.038***	1.011***	0.700***	2.060***	1.217***	0.086	0.706***
	(0.256)	(0.266)	(0.246)	(0.247)	(0.246)	(0.244)	(0.246)	(0.244)	(0.246)	(0.251)	(0.247)
Year 2016*Mining districts	-4.716***										
	(0.819)										
Neighbouring districts		1.911***									
		(0.418)									
Year 2016*Neighbouring districts		-0.039									
		(0.645)									
0–20 km radius			-7.934***								
			(1.114)								
Year 2016*0-20km radius			-1.545								
			(1.547)								
20–30 km radius				-10.064***							
				(0.874)							
Year 2016*20-30km radius				0.701							
				(1.343)							
30–40 km radius					9.193***						
					(1.380)						
Year 2016*30-40km radius					-9.548***						
					(1.793)						
40–50 km radius						-1.354					
						(1.330)					
Year 2016*40-50km radius						-7.910***					
						(2.174)					
50–60 km radius							-3.133***				
							(1.079)				
Year 2016*50-60km radius							10.151***				
							(1.674)				
60–70 km radius								49.576***			
								(1.040)			
Year 2016*60-70km radius								-55.712***			
								(1.557)			
70–80 km radius									16.421***		
									(0.905)		
Year 2016*70-80km radius									-12.485***		
									(1.435)		
80–90 km radius										-2.276***	
										(0.515)	
Year 2016*80-90km radius										15.489***	
										(1.034)	
90–100 km radius											13.226***
											(0.715)
Year 2016*90-100km radius											6.396***
											(1.241)
Household size	0.965***	0.961***	0.957***	0.966***	0.969***	0.960***	0.962***	0.923***	0.959***	0.960***	0.973***
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
Cluster altitude	-0.008***	-0.007***	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***	-0.007***	-0.008***	-0.008***	-0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age head of household	-0.017***	-0.016**	-0.016**	-0.016**	-0.016***	-0.017***	-0.016**	-0.016**	-0.016**	-0.015**	-0.018***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Observations	133,295	133,295	133,295	133,295	133,295	133,295	133,295	133,295	133,295	133,295	133,295
R-squared	0.014	0.014	0.015	0.015	0.014	0.014	0.014	0.030	0.016	0.015	0.019

Notes: Standard errors in parentheses. For all columns the dependent variable is Time to water in this table. Column 1 shows results of the DiD model equation 4.1 with the interaction term of Year 2016 * Mining districts being the focus of the analysis. Column 2 shows results of the DiD model equation 4.2 with the interaction term of Year 2016 * Neighbouring districts being the focus of the analysis. Column 3 shows results of the DiD model equation 4.3 with the interaction term of Year 2016 * 0-20km radius being the focus of the analysis. Columns 4 to 11 repeat the latter approach up to 90-100km respectively. All regressions used OLS. ***p < 0.01, **p < 0.05, *p < 0.1

Chapter 5: Impacts of LSM in Madagascar at the household level

5.1 Introduction

As explained in the previous chapter, households within a 0–20 km radius benefited more from mining than those living further away. But these results do not differentiate the experiences of communities within this distance to the mine. As a result, this chapter is concerned with the assessment of the impacts at local level. In the literature, once more, there is a stark contrast between findings from international donors compared to research conducted by CSOs, NGOs or academics. These contradictions may also stem from differences linked to disciplines and methods, such as data sources, the use of secondary or primary data, and differing sampling strategies. To address the problem of conflicting perspectives about the economic and social impacts of LSM in Madagascar at the local level, this chapter uses both secondary and primary data, and a systematic sampling strategy within 0 to 20 km of the QMM and Ambatovy mines, the two largest mines in operation. Both mines were chosen given the size of their investment and the fact that they started operating respectively at the end of 2008 and 2013, which enables to have a sufficient amount of time to assess the “before” and “after” mining. Primary data comprise household surveys and interviews of key mining stakeholders. This enables the triangulation of information to obtain an objective picture of the impacts of LSM on local communities. This is the first independent and comprehensive study examining the economic and social impacts of these mines in Madagascar. The novelty of the study is to provide evidence that households in the vicinity of QMM have not benefited from LSM as much as those around Ambatovy, that workers in mining fare much better than their counterparts

working in other sectors, and finally that those living the closest to the mines are not those who benefit most from mining activities.

The remainder of this chapter is structured as follows. Section 5.2 provides a background about both mines and their respective local areas, to set the context of the analysis. Section 5.3 briefly discusses the literature of the impacts of LSM at the local level in the vicinity of either mines. Section 5.4 presents the methods and methodology and outlines the data. Section 5.5 reports the results. It focuses first on a comparison of economic and social outcomes for households near QMM and Ambatovy, then for those working in mining relative to other sectors, and then by distance to the mines. Finally, Section 4.6 concludes and suggests policy implications.

5.2 Background: two mines, two contexts, two approaches

Despite being the largest mines currently in operation in Madagascar, the QMM and the Ambatovy mines are vastly different. The size of the initial investment was USD1 billion for QMM (QMM Rio Tinto 2020) versus USD8 billion for Ambatovy (Ambatovy 2019). Ambatovy is the largest ever foreign investment in the country – and one of the biggest in sub-Saharan Africa and the Indian Ocean region. It ranks among the largest lateritic nickel mining entities in the world (Ambatovy 2019). The minerals extracted and their volatility on the international market have also greatly varied. QMM extracts mainly ilmenite that has been on a downward trajectory since 2012 (Canavesio 2014, Medinilla 2016, World Bank 2015b) while Ambatovy mainly mines nickel, cobalt and ammonium sulphate, the prices of which have experienced less volatility over the years (Sherritt International Corporation, World Bank 2015b). In terms of operations, these mines also have different models. The QMM mine extracts the minerals near the city of Toalagnaro and ships them – from the nearby deep-water Ehoala port

constructed to export the minerals – to be transformed in Canada (Sumner et al. 2010). At Ambatovy, the minerals are extracted near Moramanga and transported over 220 km via a pipeline to Toamasina where they are transformed before being shipped. The locations of these mines are provided in appendices 5.1-5.3. QMM is based on the coastline of southeast Madagascar while Ambatovy mine is inland, in a protected forest reserve 120 km east of the capital.

Both mines also differ by the socio-economic situation of the areas around them and the mining laws they are subject to. The QMM mine entered the construction phase in 2005 for three years in one of the historically poorest areas of Madagascar (World Food Programme 2005) with a local economy at the time mainly characterised by subsistence fishing and farming, and traditional craft making (Revéret 2006, Ramdoo and Randrianarisoa 2016). This mining project was at the core of the local and regional growth strategy as part of a World Bank “growth pole” USD165 million program which involved building essential infrastructure to support the mining operations and local development such as the Ehoala port and main roads (World Bank 2015b). As a result of these investments, the transformation of the area including Toalagnaro has been remarkable compared to before 2005. In contrast, the Ambatovy mine started being built in 2007 in a relatively less poor area. Furthermore, the direct impacts on mining communities differed. The Government of Madagascar (GoM) estimated a total of 45,000 people directly affected by the project, either resettled or requiring compensation and/or mitigation measures (GoM 2005) and 6,000 hectares of coastal forests for QMM were destroyed (Revéret 2006). In comparison, the Ambatovy mine and its pipeline only directly affected fewer than 3,000 people (Dynatec Corporation of Canada on behalf of the Ambatovy Project 2006) and 2,500 hectares of forest home to endemic species (Friends of the Earth 2013).

Finally, the economic and political contexts during which these projects were approved were also fundamentally different, which is reflected in their ownership, tax, and legal frameworks. QMM is a joint venture between Rio Tinto (80%) and the Malagasy government (20%) through the Office of National Mining and Strategic Resources (OMNIS). It is governed by a unique 'Convention d'Établissement', while Ambatovy is subject to the Law on Large Investments designed to foster large investments by offering a legal and tax framework as well as investment incentives (Chambre des mines Madagascar 2014, Reyes and Rames 2015). QMM's operating permit was approved in 2005 under President Ravalomanana, "*a young, self-made tycoon promising progress"* (Sarrasin 2009 p. 171). His support to the mine was *"in the hope that it will generate jobs and funds for the exchequer"* (Sarrasin 2009) and to make Madagascar an African success story thanks to economic liberalisation reforms funded by the World Bank (Sarrasin 2006b, Smith, Shepherd & Dorward 2012). As for Ambatovy, its operating permit was granted in 2012 at a time where Madagascar was going through one of its most acute political crises and was led by a four-year temporary government (Reyes and Rames 2015). This political crisis started when the South Korean company Daewoo and Indian company Varun initiated the process of acquiring two million hectares in the country (Evers, Seagle and Krijtenburg 2013). The USD25 million in social funds from Ambatovy was negotiated to prevent outrage and manage discontent towards foreign companies (Reyes and Rames 2015). So far, no other large-scale exploitation project has since been established (EITI 2018).

As a result, the ambitions and expectations of these mining companies are different. For QMM, goals have been revised down to" regional *and national growth, infrastructure development, and improved livelihoods"* over the course of its current 30 years mining permit (Rio Tinto 2020 p.1) while Ambatovy's goal for the next 20 years

is to *"create lasting prosperity for all stakeholders and contribute significantly to sustainable development in Madagascar"* (Ambatovy 2017). "*Ambatovy will generate important economic and social benefits through the payment of taxes and royalties, investment in infrastructure, job creation, local business development, and technology transfer as well as training, education, and health-related programs"* (Macnaughton 2021).

Therefore, based on this initial analysis of the context and key characteristics of their operations, the arrival of Ambatovy seems more likely to have benefited local populations. The next section summarises the existing literature examining the economic and social impacts in the communities in vicinities since their respective construction phase (2005 and 2007).

5.3 Literature review

Numerous references were found on mining impacts at the local level near Ambatovy and QMM that focus on the environment, conservation and biodiversity offsets. This may be due to the existence of the unique biodiversity in Madagascar (Revéret 2006, Sarrasin 2007), especially in both of these locations. Further, the Social and Environmental Impact Assessment (SEIA) conducted by QMM during 1998–2001 was the first of its kind ever conducted in Africa (Olegario 2012) and marked a precedent for other sub-Saharan African countries as well as arousing the interest of researchers. Yet, studies focusing on economic and social impacts are scarce with only eight. Of these, six were commissioned by the World Bank or the IIAP and only three study the Ambatovy mine. In addition, it is worth noting that some of these studies were written before the operating phase in 2008 and others focus on potential risks – not actual

impacts – based on existing vulnerabilities. Similarly, one of the key economic studies from the World Bank is based on forecasts not on actual data (World Bank 2015b).

Overall, there seems to be a strong opposition in findings between studies conducted or commissioned by international donors and mining companies and research led by academics or CSOs. Some of these contradictions could stem from differences across disciplines and methodologies. The former type of reports present LSM as having been generally beneficial to local communities mainly by creating jobs (directly and indirectly), building infrastructure, broadening access to basic services, supporting entrepreneurship and training, and providing revenues to local authorities (IIAP 2011, 2014, 2017, 2019, World Bank 2015b).

> *"Rio Tinto has proven (to be) an essential partner to the World Bank and the Government of Madagascar (GoM) in transforming Fort Dauphin from a poor famine-stricken outpost to a budding tourist destination and a source of significant natural resource revenue for the GoM."* (World Bank 2015b p.82)

In these official reports, social conflicts on land disputes and pollution of natural resources are often acknowledged and presented as under control. The quality of community consultation is often outlined. Some INGOs are presented as essential stakeholders for these mining projects as they represent the local communities. Conservation strategies from mining companies are presented as the only way to salvage the unique fauna and flora in the locations (Evers & Seagle 2012, Huff & Orengo 2020).

Yet, research led by academics or CSOs often sheds a different light on community experiences of LSM. To start with, they highlight that infrastructure benefited the

mining operations and the mine's staff, not the local population (Canavesio 2014). The Ehoala deep-water port built near QMM has limited use for most inhabitants as they work in agriculture or fishing not in logistics or tourism (Ramdoo & Randrianarisoa 2016). Worse, the development of this port has pushed fishermen further away to more hostile waters (Andrews Lee Trust 2009). In terms of jobs created, this category of literature seems to underline the gaps between what was initially announced before the mining project started and the much lower number of people recruited in reality or the drop in employment after the construction phase. In addition, a few of these studies highlight that many of these jobs either go to expatriates or Malagasy nationals from other regions or tribes, and do not benefit locals (Friends of the Earth 2013, Direction Régionale de l'économie et du plan à Anosy 2016). In these studies, the economic benefits are depicted as meagre compared to the cost on mining communities' livelihoods (Ballet & Randrianalijaona 2014, Scales 2014, Kill & Franchi 2016). Moreover, there are accounts of unresolved social conflicts mainly because of land compensation disputes (Huff, Orengo & Ferguson 2018) and the "greenwashing" role of the large INGOs (Huff, Orengo & Ferguson 2018, Gerety 2019) involved are numerous. These studies also tend to highlight a lack of communication and consultation with all members of local communities. They also underline how the arrival of international mining companies has deeply disrupted the traditional social equilibrium to further foster inequalities and tensions (Mulligan 1999, Andrews Lee Trust 2009). The negative impacts on the environment are mentioned in most of these studies. Finally, many of these scholars emphasised the role played by previous national governments and international institutions; and more specifically the World Bank in encouraging the Malagasy government to adopt a series of structural adjustment programs (SAPs) or similar governmental reform programs in the 1990s

and 2000s. Most importantly, they underline how the new mining legislation was shaped to facilitate the dealings of Rio Tinto and the role the World Bank played in the neoliberalisation process (Campbell 2004, 2009, Sarrasin 2006b, 2009, Huff, Orengo & Ferguson 2018).

Thus, there is no clear consensus on whether LSM – and more specifically QMM and Ambatovy mines – has been beneficial to local communities in Madagascar. Yet, beyond the potential differences in agendas between international donors, mining companies, academics and CSOs, some of these contradictions could stem from differences across disciplines and methodologies. For example, there are some differences between conservation biology, environmental anthropology and economics to assess the economic and social benefits of a large-scale mine. The conceptual frameworks and the indicators used are often very different (Gilberthorpe & Papyrakis 2015, Papyrakis 2017). In addition, 15 of the studies selected solely use secondary data, even though the lack of reliability is regularly pointed out (IIAP 2011, World Bank 2015b). Most data sources come from mining companies. As a result, triangulation with other sources is often not possible (WaterAid & Moore Stephens LLP 2018). As for the remaining studies that conducted primary data collection, only half of them have a research design justifying their sampling framework. It is therefore difficult to assess to what extent stakeholders' views are equally represented and whether findings are objective. For those that detail their methodology, some have conducted only a limited number of interviews or focus groups, which also limits the objectivity of their findings. Furthermore, mixed-methods studies that can be considered as more objective by using the generalisation potential of surveys and in-depth understanding from interviews also have their own limitations: unspecified sampling framework, focus on conservation or funded by non-independent actors.

Therefore, as exposed in the systematic literature review (Chapter 2) the collection of primary quantitative and qualitative data and an interdisciplinary approach seem more adequate to assess the impacts of 15years of LSM in Madagascar at the local level, as outlined in the broader literature on the impacts of extractive industries (Armitage 2008, Slack 2009, Gilberthorpe & Papyrakis 2015, Cox et al. 2016).

5.4 Methods and methodology

As discussed in the introduction (Chapter 1) the unique contribution of this study resides in its comparison of economic and social outcomes for surrounding communities near QMM and Ambatovy, mining workers relative to other workers, and finally by distance to the mine with a level of granularity not obtained by regional studies using DHS data. The period covers the construction phase (2005 for QMM and 2008 for Ambatovy) to 2019, the year of field data collection. A broad range of outcomes for local communities are studied encompassing changes in income, multidimensional poverty and livelihoods, food security and health, and finally tensions, violence and community trust.

5.4.1 Research methods

Mixed methods at local level

This chapter aims to underline the differences in terms of impacts on individuals between mining and non-mining *fokontany*s, the lowest administrative division in Madagascar. It explores the changes experienced at the micro level since the start of the LSM activities. A broad range of themes are analysed, encompassing changes in livelihoods, asset ownership, education and training, or access to WASH.

Conceptual framework

The conceptual framework used to address this research question was developed by the World Economic Forum, UNDP, UN Sustainable Development Solutions Network, and the Columbia Center on Sustainable Investment in an attempt to map how mining companies should contribute to the achievements of the Sustainable Development Goals (Columbia Center on Sustainable Investment 2016, 2020). It is also aligned with how the Ambatovy mine sees ‘’its support for Madagascar’s achievement of the SDGs’’ (Ambatovy 2021). This framework acknowledges that LSM and its investments in CSR may foster improvements in reaching some of the SDGs that need to be ’enhanced’ such as No Poverty (Goal 1), Quality Education (Goal 4), Decent Work and Economic Security (Goal 8). Yet, it also outlines that LSM may have some adverse effects that require ‘mitigation’ (e.g., Gender Equality, Goal 5 or Good Health and Well-being, Goal 3). The framework is presented in Figure 28. This framework also highlights the existence of “direct” (e.g., Industry innovation and infrastructure, Clean water and sanitation, Life on land) and “indirect” impacts (e.g., No Poverty, Gender Equality, Zero Hunger). This means that LSM can either directly affect a given outcome or indirectly contribute to an outcome.

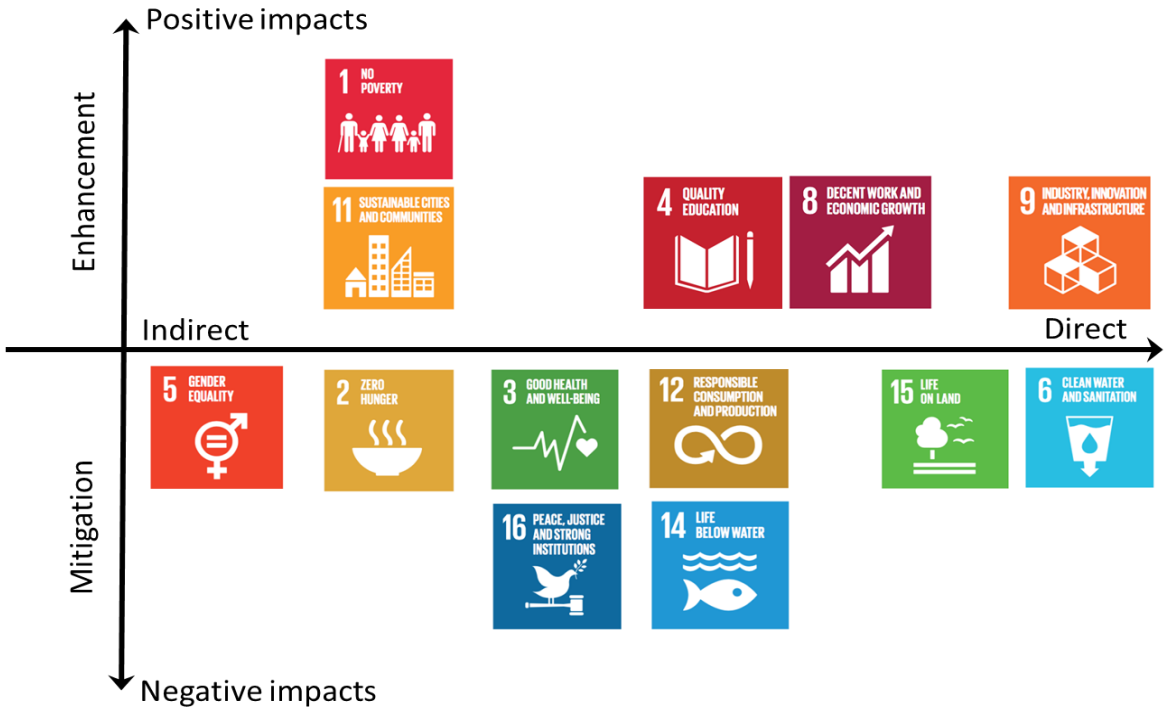


Figure 28: Selected impacts of LSM at the micro level

Source: Author, based on WEF, UNDP and CCSI framework

5.4.2 Methodology at micro, household and individual level

The methodology used to address this research question is tailored to an analysis at the individual or household level. It focuses on individuals' experiences of change since the start of LSM activities relative to individuals in comparable households in non-mining fokontanys through examining outcomes within 0–10 km, 11–15 or 16–20 km of the vicinity of QMM or Ambatovy. For the purpose of this study, it is considered that mining communities are those within a 10 km-radius to QMM or Ambatovy mines. It employs individual surveys and semi-structured interviews, triangulated by secondary data when available. Individual surveys focused on the changes that have occurred since the start of the LSM activities, while the semi-structured interviews aimed to capture more of the historic and cultural background leading to the local economic and social impacts.

Semi-structured interviews

The interviews were conducted in parallel to the individual surveys with a wide range of stakeholders as recommended in the *Resources Endowment Toolkit: Assessment of Economic and Social Impacts of Large-Scale Mining* (ICMM 2008). A full version of the semi-structured questionnaires can be found in Appendix 5.5.

Individual surveys

Individual surveys were conducted to obtain an understanding of the economic and social impacts at the local level for individuals living in mining and non-mining communities. Interviews done with some key informants prior to the survey data collection contributed to inform the development of the survey, more specifically by identifying the questions that could be used from previous large-scale surveys and the main types of changes to be investigated. As such, the survey questions were based on those from the national census, Enquête Périodique auprès des Ménages (EPM [INSTAT 2010]), SDG indicators, Multidimensional Poverty Index indicators (MPI [UNDP 2014b])), and on those from a study on the state of governance and security in Madagascar (Rakotomanana et al. 2016). Questions were adapted to the local context. Individual surveys focused on the changes that have occurred since the start of the LSM activities in terms of key economic and social outcomes. Questions related to “before” LSM operations were added to the survey. A full version of the survey can be found in Appendix 5.4.

The survey was designed to capture the following five main types of changes since the arrival of the mines: (1) in employment, income and livelihood; (2) in access to natural resources; (3) in asset ownership (including land); (4) in health, access to WASH; and (5) in community trust, tensions and violence. The survey was piloted with

12 individuals (in mining (6) and non-mining communities (6)) as well as with the six research assistants and the research coordinator. The questions were refined to include their feedback before the start of the data collection.

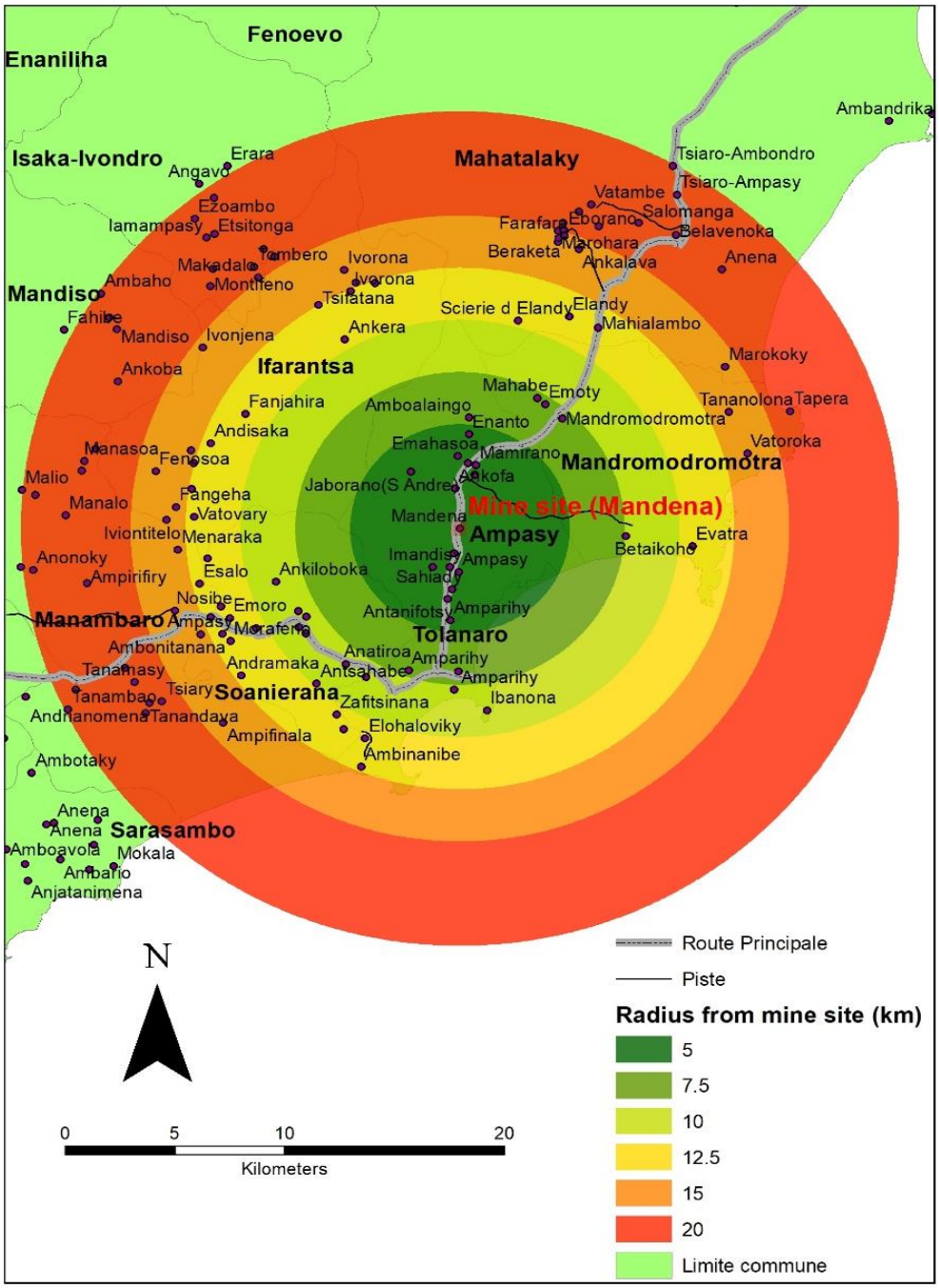
The aim of the quantitative data collection was to obtain a representative sample of the affected population. The locations were chosen based on their distance to the mines as described in Table 26.

Table 26: Number of locations surveyed per mine and distance to mines

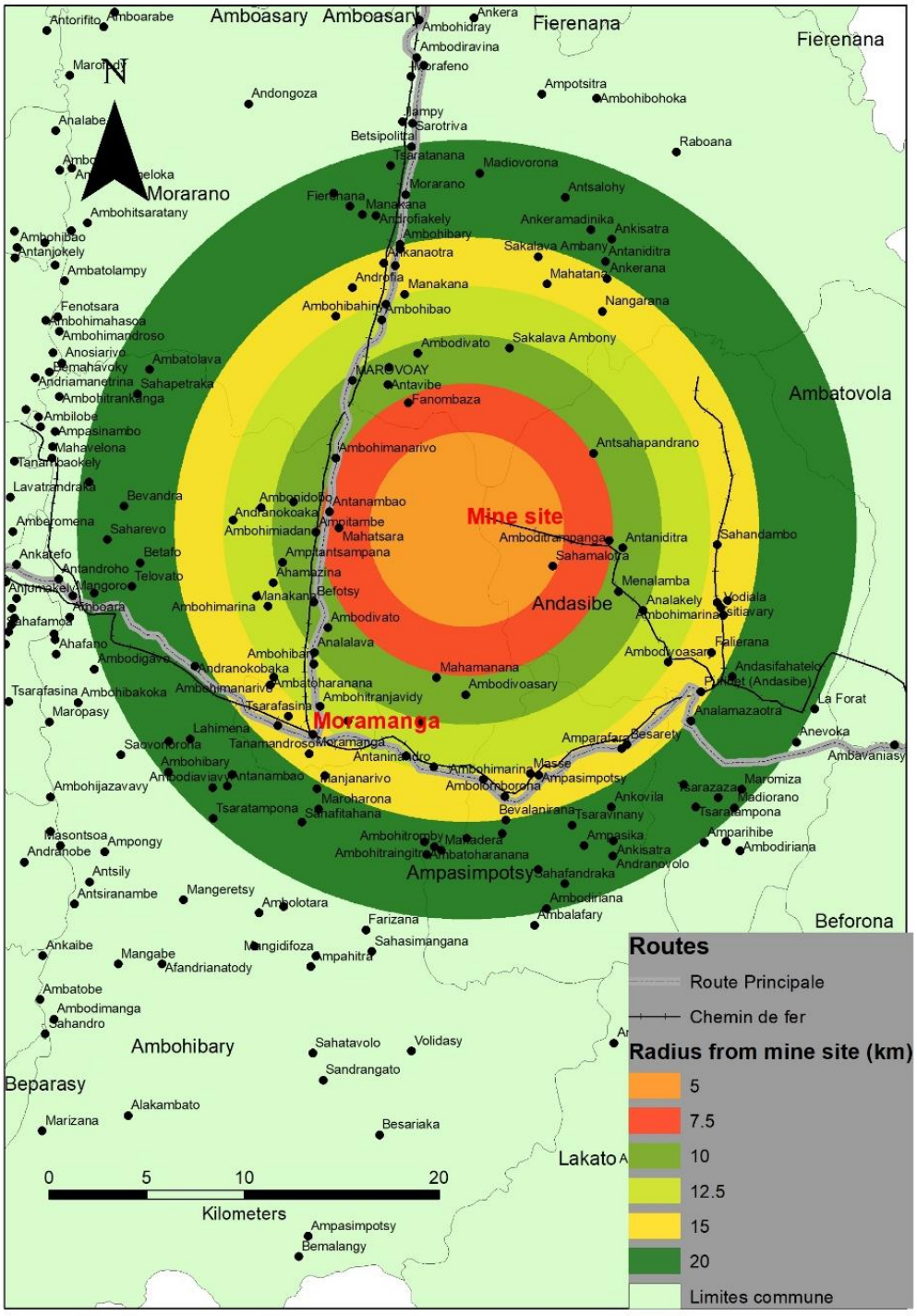
Mine	Date	0–10 km	11–20 km	Total
Ambatovy	May 2019	6	8	14
QMM	June 2019	9	11	20
	Total	**15**	**19**	**34**

The selection was done using maps 7 and 8, developed with geographic information system (GIS) coordinates of the mines and surroundings.

Map 7: Locations selected by distance to the QMM mine



Map 8: Locations selected by distance to the Ambatovy mine



Source: Author, using GPS coordinates

Once the locations were chosen, the size of the sample to be collected by location was based on the size of the local population. This information was given by the

regional and local government representatives during the “visite de courtoisie” and semi-structured interviews. The total size of the sample is 730.

Table 27 shows the breakdown of the number of individual surveys collected by mine and by distance.

Table 27: Breakdown of the number of individual surveys collected by mine and by distance

Mine	Date	0–10 km	11–20 km	Total
Ambatovy	May 2019	225	143	368
QMM	June 2019	167	195	362
	Total	**392**	**338**	**730**

This enables the measurement of variables in communities “with” and “without” mines in addition to a “before” and “after” approach.

The recruitment of potential participants was done in two phases:

- First, in each of the locations the local fokontany leader was approached to introduce the purpose of the study and the survey. This enabled the gathering of key missing information such as location population size, preferred days to collect the surveys depending on local events or customs (elections, church etc.).
- Then, the target sample size per fokontany was set and the data collection started.

The eligibility criteria for survey respondents were:

i. Where they live (must be in one of the selected locations)
ii. Adult of the household
iii. At least 18 years of age and in a physical and mental condition to respond truthfully
iv. Have lived at this location before the arrival of the mines and for at least 10 years (Ambatovy) and 13 years (QMM)

Therefore, the sampling technique was both by cluster (divided by a natural boundary) and stratification (divided based on profile characteristics).

During the data collection, the key characteristics of the respondents were monitored in order to obtain a balanced sample which was as representative as possible of the local population. These figures were obtained from INSTAT, the World Bank and International Labour Organization (ILO). The sampling framework presented in Table 28 shows that the sample collected has a much greater proportion of people employed than the national average (21% vs 11%) and of people being 40 years old and older (60% in total vs 39%). Yet, this overrepresentation of these age brackets can be mostly due to the selection criteria “Are you an adult of the household contributing to the financial decisions?”

The survey was administered by local researchers speaking the local dialect but who were not from the selected communities. The 13 local researchers were recruited based on their skills, their ability to speak the local dialect and their independence to the mine. The survey administration process is described in detail in Appendix 5.6.

Table 28: Individual survey sampling framework

Local population characteristics	Detail of characteristics	Sample proportion	Sample target	Source
Gender	Women	56% (410)	51% (Anosy) / 50% (Alaotro Mangoro)	INSTAT 2020a, p. 22
	Men	44% (320)	49% (Anosy) / 50% Alaotro Mangoro	
Involvement with industrial mine	Directly employed by mine	3% (22)	2% (national)	World Bank 2015b, p. 17
	Not directly employed by mine	97% (708)	98% (national)	
Occupation type	Employed	21% (158)	11% (national)	World Bank 2019
	Self-employed	78% (572)	89% (national)	
Formal/informal sector	Formal	12% (88)	6% (national)	OIT 2019, p. 89
	Informal	88% (642)	94% (national)	
Age bracket	20–24	3% (23)	20% (national)	INSTAT 2020b, p. 26
	25-49	60% (441)	59% (national)	
	50–59	18% (129)	11% (national)	
	60 and above	19% (137)	10% (national)	

Model

Based on the existing literature on local economic and social impacts of LSM in Madagascar and other mining exporting countries, three main hypotheses are tested in this study.

Hypothesis 1: Communities around Ambatovy are better off and have benefited more from the mine arrival than those around QMM (as discussed in Background section 5.2).

Hypothesis 2: Those who work in mining have better economic and social outcomes than those who work in other sectors (World Bank 2015b, Weber-Fahr 2001) but are socially excluded (Narayanan 2016, Quodling 1991).

Hypothesis 3: Households that are the closest to the mines benefit more from LSM (Loyza & Rigolini 2016, Chuhan-Pole, Dabalen & Land 2017).

To examine the economic, health and social impacts from mining using the survey data, the following empirical model is specified and estimated:

$$Y_{i,f} = \alpha + \beta_1 QMM_{i,f} + \beta_2 Mining_{i,f} + \beta_3 C_{i,0-10km} + \beta_4 C_{i,11-15km} + \beta_6 X_{i,f} + \varepsilon_{i,f} \quad \textbf{(5.1)}$$

Where:

- $Y_{i,f}$ represents economic, health or social outcomes from mining for individual i in fokontany *f* proxied by the 12 following outcomes: income, changes in income, multidimensional poverty and changes in multidimensional poverty, changes in livelihood, food security and changes in food security, health and changes to health, assaults, levels of community tension/violence and trust.
- QMM is a dummy variable that takes 1 if community members live in the vicinity of the QMM mine
- $Mining$ is a dummy variable that takes 1 if community members work in mining
- *C* is a vector of dummy variables that take the value of 1 if community members live within 0–10 km or 11–15 km from the mine
- $X_{i,f}$ controls for household characteristics for individuals i in fokontany *f* such as household size, relationship status, level of education, employment sector and contract status
- $\varepsilon_{i,f}$ is the error term

The sign, size and significance of the coefficient of the four explanatory variables ($QMM, Mining, C_{i,0-10km}, C_{i,11-15km}$) are the focus of this chapter for each of the 12 outcome variables.

Ordered probit models are estimated for all categorical and ordered variables with more than two outcomes, i. e. income level, income change, livelihood change, health level and trust in local community. For categorical and ordered variables with only two outcomes, the probit model is applied (deprivation MPI index, meals skipped, health change). Finally, for the four continuous variables (i.e. deprivation MPI score, protein intake change, time to drinkable water, and assaults) OLS is used. The detail of all these variables is presented in Table 30. The next section presents the qualitative and quantitative data collected at local level.

5.4.3. Data

Primary qualitative data

The semi-structured interviews were conducted at the local level to capture the impacts of LSM within the local context in parallel to the individual survey collection. The questionnaire design, testing, participant recruitment and conduct of interviews followed a similar approach to the one developed in RQ1 and RQ2 and were adapted to enable a comparison between the experiences of individuals living in mining and non-mining fokontanys near the QMM and Ambatovy mines. The relatively lower number of semi-structured interviews conducted around Ambatovy is mainly due to the fact that there were fewer CSO or local Subject Matter Experts (SME) left in the area as things were overall assessed as going well for the communities and the local governments.

Table 29 presents a breakdown of interviewees conducted by type of stakeholder and mine.

Table 29: Overview of the semi-structured interviews conducted at the micro level

Categories of mining stakeholders	Ambatovy	QMM	Total
Public sector officials with role related to mining activities	4	5	9
Representatives of population, health and local authorities	13	18	31
LSM employees	3	7	10
Subject matter experts, key stakeholders of the extractive industry and suppliers to LSM industries	3	4	7
CSOs and NGOs	2	3	5
TOTAL	**25**	**33**	**62**

Primary quantitative data

The key characteristics of the depend and explanatory variables are presented in Table 30.

Table 30: Summary statistics of variables used at the local level

Variables	Unit and measurement	Obs	Mean	SD	Min	Max
Economic outcomes						
Income level	= 1 if income level between 0-150kMGA (0 to 39.6USD*)					
	= 2 if income level between 150-250kMGA (39.60-66USD*)	695	1.477698	0.752904	1	3
	= 3 if income level between 250k+(over 66USD*)					
Income change	= 1 if income has decreased since the arrival of either mine					
	= 2 if income has not changed since the arrival of either mine	697	2.002869	0.784178	1	3
	= 3 if income has increased since the arrival of either mine					
Deprivation MPI index	= 1 if not deprived	730	0.49863	0.500341	0	1
Deprivation MPI score	Deprivation score	730	0.664379	0.210149	0	1
Livelihood change	= 1 if livelihood has worsened since the arrival of either mine					
	= 2 if livelihood has not changed since the arrival of either mine	706	2.045326	0.792294	1	3
	= 3 if livelihood has improved since the arrival of either mine					
Health and food security outcomes						
Protein intake change	Difference between the number of monthly meals containing fish or meat before and after	718	-2.402507	7.001362	-36	21
Meals skipped	= 1 if never	725	0.7268966	0.4458611	0	1
Health status	= 1 very poor to poor					
	= 2 satisfying	730	2.19589	0.8453761	1	3
	= 3 good to very good					
Health change	= 1if same or improved	715	0.551049	0.4977354	0	1
Social outcomes						
Tension and violence	Level of perceived tension and violence	718	2.179666	0.7973309	1	3
Assaults	Number of assaults experienced over the past 12 months	730	0.906849	2.510244	0	30
Trust in local community	= 1 if no trust ; 2 if some level of trust ;3 if high level of trust	721	2.307906	0.7831959	1	3

** Exchange rate as of July 2019 at the time of the fieldwork*

Variables (continued)	Unit and measurement	Obs	Mean	SD	Min	Max
Explanatory variables						
$C_{i,0-10km}$	= 1 if the household lives within 10km of QMM or Ambatovy	730	0.39726	0.489666	0	1
$C_{i,11-15km}$	= 1 if the household lives within 10km of QMM or Ambatovy	730	0.350685	0.477512	0	1
16-20km (omitted variable)	= 1 if the household lives within 10km of QMM or Ambatovy	730	0.252055	0.43449	0	1
QMM	= 1 if individual lives in the vicinity of QMM	730	0.49589	0.500326	0	1
Ambatovy (omitted variable)	= 1 if individual lives in the vicinity of Ambatovy	730	0.50411	0.500326	0	1
Mining	= 1 if the individual's main source of income is from a mining job	730	0.030137	0.171081	0	1
Other sectors (omitted variable)	= 1 if the individual's main job is in construction, telecommunications, administration, education	730	0.052055	0.22229	0	1
Control variables						
Partnered relationship	= 1 if the respondent is in a partnered relationship	730	0.724658	0.446993	0	1
Having dependents	= 1 if the respondent has any dependent	730	3.356164	2.578107	0	23
Studied beyond secondary	= 1 if the respondent studied at secondary level and beyond	730	0.412329	0.492591	0	1
Primary highest education	= 1 if the respondent completed primary school	730	0.486301	0.500155	0	1
At least 6 years of schooling	= 1 if any member of the household above 13 years old has completed at least 6 years of schooling	730	0.765753	0.423817	0	1
Being self-employed	= 1 if the respondent is self-employed	730	0.783562	0.412099	0	1
Being employed	= 1 if the respondent is self-employed	730	0.156164	0.36326	0	1
Not working (omitted variable)	= 1 if the respondent is not working	730	0.060274	0.238157	0	1
Working in craftmanship	= 1 if the respondent works in artisanat/craftmanship	730	0.109589	0.312591	0	1
Working in primary sector	= 1 if the respondent works in the primary sector	730	0.468493	0.499349	0	1
Working in services	= 1 if the respondent works in services	730	0.273973	0.446301	0	1

The details of the indicators included in the deprivation MPI index and score can be found in Appendix 5.7. The MPI was chosen as a variable as it enables to understand poverty beyond monetary restrictions by including other dimensions of deprivation such as education, health and living standards.

5.5 Results

The results are presented under three types of local impacts: economic, health and social. Each section provides a combination of the findings from the 730 individual surveys, 62 interviews and secondary data collected during the fieldwork for triangulation. The economic outcomes are presented in Table 31, the health and food security outcomes in Table 32 and social outcomes in Table 33.

Table 31: Results of equation 5.1, economic outcomes for local communities

	(1) Income level	(2) Income change	(3) Deprivation MPI index	(4) Deprivation MPI score	(5) Livelihood change
	Low to high	*Decrease to increase*	*Deprived or not deprived*	*Deprived to not deprived*	*Worsen to improve*
	OPROBIT	OPROBIT	PROBIT	OLS	OPROBIT
0 to 10 km	0.062	-0.184*	0.292**	0.034**	0.322**
	(0.134)	(0.111)	(0.148)	(0.015)	(0.155)
11 to 15 km	0.253*	-0.032	0.328**	0.040***	0.288*
	(0.135)	(0.112)	(0.150)	(0.015)	(0.152)
In the vicinity of QMM	0.309***	-0.655***	-1.442***	-0.212***	-1.264***
	(0.111)	(0.100)	(0.121)	(0.013)	(0.128)
Working in mining	0.969***	1.383***	0.915*	-0.020	1.224***
	(0.302)	(0.417)	(0.473)	(0.030)	(0.384)
Partnered relationship	0.334***	0.261**	0.366***	0.037***	0.355**
	(0.126)	(0.102)	(0.135)	(0.014)	(0.140)
Having dependents	0.056***	-0.042**	-0.029	-0.008***	-0.002
	(0.021)	(0.017)	(0.022)	(0.003)	(0.025)
Studied beyond secondary	1.049***	0.359**	1.090***	0.155***	0.893***
	(0.212)	(0.161)	(0.203)	(0.023)	(0.243)
Primary highest education	0.397*	0.136	0.556***	0.079***	0.450*
	(0.209)	(0.156)	(0.198)	(0.022)	(0.238)
At least 6 years of schooling	-0.164	-0.000			1.862***
	(0.136)	(0.116)			(0.235)
Being self-employed	-0.277	0.222	0.230	0.069**	0.228
	(0.294)	(0.205)	(0.313)	(0.034)	(0.319)
Being employed	0.200	0.470**	0.464	0.106***	0.424
	(0.282)	(0.208)	(0.298)	(0.033)	(0.307)
Working in artisanat	-0.405	-0.011	-0.455	-0.115***	-0.299
	(0.258)	(0.207)	(0.295)	(0.033)	(0.299)
Working in primary sector	-0.278	-0.129	-0.314	-0.035	-0.280
	(0.224)	(0.175)	(0.256)	(0.026)	(0.251)
Working in services	0.045	0.134	0.109	-0.008	0.077
	(0.206)	(0.164)	(0.243)	(0.025)	(0.238)
Observations	695	697	730	730	730
Log-Likelihood or Pseudolikelihood	-511.41041	-687.98465	-300.0717		-699.72958
F-test				F(14,715)=79.50	
LR chi2 or r Wald Chi2	155.66	147.01	229.77		145.02
Pseudo R2 or R-squared	0.1321	0.0965	0.4070	0.452	0.0939
Omodel likelihood-ratio test	10.45	33.57			18.22
Omodel Prob > chi2	0.7288	0.0024			0.1970

Notes: Standard errors in parentheses. All columns show the results obtained with equation 5.1 applied to economic outcomes for local communities in the vicinity of QMM and Ambatovy. Signs are aligned with the nature of the outcome from negative to positive. Column 1 shows results with Income level as dependent variable. Column 2 shows results with Income change as dependent variable. Column 3 shows results with Deprivation MPI index as dependent variable. Column 4 shows results with Deprivation MPI score as dependent variable. Since At least 6 years of schooling is included in the MPI calculation, it is removed from the regressions shown in columns 3 and 4. Column 5 shows results with Livelihood change as dependent variable. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 32: Results of equation 5.1, health and food security outcomes for local communities

	(1) Protein intake change	(2) Meals skipped frequency	(3) Health Level	(4) Health level change
	Low to high intake	*Often or never*	*Very poor to very good*	*Worsen to improved*
	OLS	PROBIT	OPROBIT	PROBIT
0 to 10 km	-0.407	0.160	-0.015	-0.026
	(0.523)	(0.159)	(0.120)	(0.131)
11 to 15 km	-0.049	0.020	0.168	0.254*
	(0.554)	(0.157)	(0.120)	(0.134)
In the vicinity of QMM	-6.691***	-1.438***	-0.710***	-0.809***
	(0.573)	(0.137)	(0.102)	(0.112)
Working in mining	0.090	0.552	-0.143	-0.260
	(1.590)	(0.488)	(0.316)	(0.354)
Partnered relationship	0.795	0.153	-0.026	-0.169
	(0.546)	(0.135)	(0.103)	(0.117)
Having dependents	0.175	-0.016	0.016	-0.020
	(0.121)	(0.023)	(0.019)	(0.020)
Studied beyond secondary	-0.259	0.397*	-0.047	-0.327*
	(0.881)	(0.205)	(0.154)	(0.185)
Primary highest education	-1.117	0.295	-0.247*	-0.412**
	(0.879)	(0.188)	(0.144)	(0.174)
At least 6 years of schooling	0.761	0.149	0.195*	0.130
	(0.721)	(0.139)	(0.110)	(0.130)
Being self-employed	2.216*	0.356	0.848***	1.136***
	(1.161)	(0.297)	(0.259)	(0.291)
Being employed	2.263*	0.359	0.852***	0.994***
	(1.190)	(0.283)	(0.243)	(0.281)
Working in artisanat	-0.773	-0.191	-0.499**	-0.621**
	(1.142)	(0.273)	(0.237)	(0.260)
Working in primary sector	-1.388	0.063	-0.291	-0.760***
	(0.957)	(0.248)	(0.208)	(0.232)
Working in services	-0.759	0.238	-0.360*	-0.387*
	(0.945)	(0.236)	(0.201)	(0.222)
Observations	718	725	730	715
Log-Likelihood or Pseudolikelihood		-322.4224	-719.81411	-436.93962
F-test	F(14, 703) = 17.68			
LR chi2 or r Wald Chi2		182.88	101.46	101.31
Pseudo R2 or R-squared	0.257	0.2415	0.0658	0.1117
Omodel likelihood-ratio test			24.61	
Omodel Prob > chi2			0.0386	

Notes: Standard errors in parentheses. All columns show the results obtained with equation 5.1 applied to health and food security outcomes for local communities in the vicinity of QMM and Ambatovy. Signs are aligned with the nature of the outcome from negative to positive. Column 1 shows results with Protein intake change as dependent variable. Column 2 shows results with Meals skipped frequency as dependent variable. Column 3 shows results with Health level as dependent variable. Column 4 shows results with Health level change as dependent variable. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 33: Results of equation 5.1, social outcomes for local populations

	(1) Level of tension and violence	(2) Number of assaults	(3) Trust level in the community
	Low to high	Low to high	Low to high
	OPROBIT	OLS	OPROBIT
0 to 10 km	-0.218*	0.627***	-0.025
	(0.114)	(0.208)	(0.112)
11 to 15 km	-0.176	0.164	0.107
	(0.117)	(0.177)	(0.115)
In the vicinity of QMM	0.228**	0.541**	0.177*
	(0.096)	(0.220)	(0.100)
Working in mining	0.007	-0.222	0.449
	(0.279)	(0.717)	(0.298)
Partnered relationship	0.062	0.004	-0.326***
	(0.097)	(0.183)	(0.106)
Having dependents	0.001	0.031	0.003
	(0.017)	(0.042)	(0.020)
Studied beyond secondary	0.389**	0.713**	-0.130
	(0.170)	(0.313)	(0.167)
Primary highest education	0.308*	0.124	-0.227
	(0.159)	(0.261)	(0.162)
At least 6 years of schooling	-0.058	-0.126	0.071
	(0.117)	(0.273)	(0.120)
Being self-employed	0.364	0.175	0.058
	(0.256)	(0.422)	(0.263)
Being employed	0.482**	0.720	-0.200
	(0.242)	(0.492)	(0.252)
Working in artisanat	-0.230	-0.523	-0.262
	(0.238)	(0.408)	(0.235)
Working in primary sector	-0.286	-0.246	0.095
	(0.211)	(0.395)	(0.196)
Working in services	-0.254	-0.363	-0.220
	(0.199)	(0.412)	(0.189)
Observations	718	730	721
Log-Likelihood or Pseudolikelihood	-759.28708		-722.95076
F-test		F(14, 715)=2.04	
LR chi2 or r Wald Chi2	23.86		32.86
Pseudo R2 or R-squared	0.0155	0.0508	0.0222
Omodel likelihood-ratio test	34.22		25.42
Omodel Prob > chi2	0.0019		0.0307

Notes: Standard errors in parentheses. All columns show the results obtained with equation 5.1 applied to social outcomes for local communities in the vicinity of QMM and Ambatovy. Signs are not aligned with the nature of the outcome; they go from better (negative) to worse (positive). Column 1 shows results with Level of tension and violence as dependent variable. Column 2 shows results with Number of assaults as dependent variable. Column 3 shows results with Trust level in the community as dependent variable. ***p < 0.01, **p < 0.05, *p < 0.1.

5.5.1 Communities around Ambatovy are better off and have benefited more from the mine arrival than those around QMM

The hypothesis that communities around Ambatovy are better off and have benefited more from the mine arrival than those around QMM is confirmed by this study. All the economic, health and social outcomes support this, except income levels and levels of trust that are higher around QMM. According to interviewees, the mining activities have partly reduced but not offset the historical poverty gap before the arrival of the mines between both areas, partially due to the relatively smaller mining operations for QMM and the remoteness of Toalagnaro compared to Moramanga, the main cities near the mines (see Background section 5.2). This result indicates that

Economic outcomes

Around Moramanga, most interviewees highlighted that changes have not been as *"visually spectacular as in Toalagnaro"* but have benefited a wider group as illustrated by *"more houses built in durable material"* and 'tuk tuk drivers'[15] who can now afford *"bikes to drag their tuk tuks instead of pulling them"*. In contrast, the economic development of Toalagnaro over the past 10 years is visually striking, thanks to the investments of both the Pôle Integré de Croissance (PIC) and QMM in roads, port, power and water infrastructures. This enabled the area to *"transform the roads of dust"* and *"enter the 21st century"* respectively, said an employee of a CSO and a local representative of authority. However, the data collected for this study confirm that the distribution of this economic development hasn't been as *"diffuse"* as around Ambatovy. Moreover, the majority of communities around QMM report doing worse than before the arrival of the mine. Most households also reported an increase in their expenses since the arrival of the mines

[15] Three-wheeled motorised vehicle used as a taxi.

(62.1% near Ambatovy and 79.9% near QMM), especially in terms of food, education and health expenses.

Surprisingly, households in the vicinity of QMM are significantly more likely to report a higher level of income compared to those near Ambatovy (Table 31, Column 1). Yet, these households also tend to report a drop in their income since the mine arrival (Table 31, Column 2). In addition, in the vicinity of QMM, households are associated with a significantly higher chance of experiencing deprivation proxied by the MPI (Table 31, Column 3) and worse MPI deprivation scores (Table 20, Column 4). They also tend to report a significant worsening of their livelihoods since the mine was established (Table 31, Column 5) compared to similar households near Ambatovy. All the above results are significant at the 0.01 level. When asked whether this decrease was linked to the mine, 68.0% said “yes” near QMM versus 21.3% near Ambatovy. Interviewees acknowledged that around Toalagnaro, the level of disruption for local communities has been greater. This was explained during the interviews as being the result of more people being directly impacted by land acquisition and relying on jobs that have been more impacted by the arrival of the mine (e.g. agriculture, craftmanship, fishing and tourism). A large number of people have experienced a partial or complete loss of their main income stream due to the mine operations. For example, those who had to part from their arable land can’t fish as much or have restricted access to the raw material *mahampy* to wove baskets and other traditional Malagasy craft. To support some of those affected, QMM has been implementing programs such as the Livelihood Program to support the transition to more efficient agriculture or craftmanship. In parallel, the mining company has been funding a regional business centre called “CARA” to foster the development of entrepreneurial projects.

Despite these results, interviews with key informants confirmed that communities around QMM have benefited from the local economic development. *"There have been some improvements, economically speaking and for their livelihoods"* highlighted the Director of a UN Programme before adding *"but they are not sufficient compared to what was expected, people are very frustrated"*. Some of these improvements are reflected in the surveys by a broader access mobile network (+42.7% near Ambatovy and +48.1% near QMM), improved sanitation[16] (+16.6% near Ambatovy and +29.3% near QMM) and access to clean water within 30 minutes[17] (+7% near Ambatovy and +16% near QMM). In a country like Madagascar, where diarrhoea is one of the top causes of death (World Bank Water and Sanitation Program 2012), having access to improved sanitation and clean water is crucial for local communities.

Health and food security outcomes

On the impacts of LSM on health and food security outcomes, most interviewees outlined that they did not have access to reliable data to make an informed comment. As for local health authorities, they confirmed that no major outbreak of disease that would be linked to the mines' activities had been recorded by the Centre de Santé de Base (CSB) at this stage. Yet, they also underlined the limitations of data and the fact that only a minority of Malagasies attend these health centres, providing "Western medicine". Many CSBs have been built and mostly funded by the mining companies as part of their CSR policies. For a local researcher around Tolagnaro *"the mine and its expats have brought quality basic health care and a Robin hood-type of clinic that didn't exist here before"*.

[16] "*A household is considered to have access to improved sanitation if it has some type of flush toilet or latrine, or ventilated improved pit or composting toilet, provided that they are not shared*" (UNDP & OPHI 2019, p. 151)

[17] Return trip, World Bank standard (Hutton & Mili 2016, p. 7)

Nevertheless, in the vicinity of QMM, households are more likely to self-report worse health (Table 32, Column 3) and a decrease in their level of health (Column 4) since the mine opened. Both results are significant at the 0.01 level. This can be explained by the fact that Malagasies rely on their traditional healers – *ombiasy* or *dadarabe* – to treat a wide range of illnesses by habit and also affordability (Randrianarivelojosia et al. 2003). But these healers with spiritual powers use medicinal plants and therefore the access to medicinal plants is essential for these traditional healing practices to occur. Yet, near QMM 66.2% of the survey respondents declared that *"It is more difficult to access medicinal plants since the arrival of the mine"*, versus 41.2% for those near Ambatovy. The econometric analysis also reveals that households near QMM reported a sharp drop in their monthly average animal protein intake (Table 32, Column 1) and are more likely to have skipped meals (Table 32, Column 2) since the arrival of the mine, which is concerning for their overall health and food security. All these health and food security results are significant at the 0.01 level. It is also worth noting that in the Malagasy traditional diet, meals with animal proteins are considered essential. Interviews with local authorities, and representatives of health, fishing industry and CSOs underlined that this was mainly due to the more frequent loss of land previously used for subsistence farming now used for mining operations or biodiversity conservation, and the drop in fishing activity with the construction of the Ehoala port.

In terms of infectious diseases, no statistics could be found for communities located close to the mines. However, several interviewees providing health services or support to sex workers pointed out the increase in HIV cases since the construction phase of both mines. These interviewees in both areas talked about the *"riskier behaviour"* of younger women and a rise in prostitution, especially for under-15-year-old girls.

Social outcomes

As for social outcomes, interviewees were 4.3 times more likely to comment on the negative social impacts of LSM on local communities rather than positive ones. The level of social disruption, inequality and discontent seem equivalent around both mines except the community protests, which were more prevalent near QMM. *"How to comprehend the activities of such a large and modern company when you're a poor and illiterate subsistence farmer"* sighed a QMM mining worker. Thus, the econometric analysis reveals that individuals in the vicinity of QMM are more likely to report an increase in "perceived" tensions and violence (Table 33, Column 1) and a higher number of personal assaults (Table 33, Column 2). Both coefficients are significant at the 0.05 level. Yet, near QMM, 75.9% of respondents said this evolution was not due to the arrival of the mine (vs 89.7% near Ambatovy). Interviewees near QMM associated this trend with the trauma left by the *dahalo*, the armed zebu stealing gangs, who used to be very active in the region. Often in Madagascar, the level of perceived insecurity can be much higher than the actual threat, as shown in previous studies (Razafindrakoto, Roubaud & Wachsberger 2020). In addition, tension and violence can come from a disruption of *fomba* customs (e.g. access to sacred sites, places or natural resources) since the arrival of the mine. Out of those who are acknowledging a change in the practice of their local customs, 86.9% live near QMM (vs 19.3% for those near Ambatovy). Only 32.2% are attributing these changes to the arrival of the mine.

Surprisingly, given how social tensions and unrest are often portrayed in the media, literature and the interviews, those living near QMM tend to report significantly higher levels of trust in the members of their local community (Table 33, Column 3) than those living around Ambatovy (0.1 level). Furthermore, in both mining areas the assessment of the local authorities' transparency is much higher than overall in the rest of the country

according to the statistics from the report *State of governance and security in Madagascar* (Rakotomanana et al. 2016). Near QMM and Ambatovy, 66.8% of households consider that the consultation of citizens before decision-making is well done (vs 35.0% for the rest of the country), 52.6% feel well informed in terms of local development and budget use (vs 36%), and 74.9% praise the consultation of traditional chiefs in decision-making processes (vs 40%). It must be noted that at the time of the fieldwork, the mining revenues from Ambatovy had just been paid after four years of waiting due to issues with the legal and tax framework between the national Ministry of Economy and Finances and its local decentralised branches. These findings show that local populations in mining areas are eager to be even more informed and involved in decision-making, even though relative to the rest of the country they are already far ahead. It can also reveal a change in attitude towards power compared to 2014 after five years of political crisis, when the data for the reference study was collected.

Thus, our analysis shows that for LSM to foster sustainable local development, several conditions need to be met. To start with, the size of the investment by the mining company must be large enough that it will hire more local people and create more indirect work through procurement contracts. Then, the number of people disrupted by the mine arrival needs to be as small as possible. In areas with limited economic opportunities and low education level, transitional programs will not be sufficient to enable those who have lost their main revenue source (e.g. fishing or agriculture). Finally, both of the previous conditions are even more important if a mining company aims to operate from “a poor famine-stricken outpost” area like Toaloagnaro used be (World Bank 2015, p.82)

5.5.2 Working in mining provides considerably better economic and social outcomes without creating social exclusion

As expected, those who work in mining either directly or indirectly have better outcomes on all indicators, except health-related ones.

Economic outcomes

"Please ask the mining company to give us jobs", said a fokontany leader, echoing what was heard every day during the field data collection near both mines. The survey data gives more explanation about why people would be so keen to work for such employers. To start with a much larger proportion (68.2%) of people working in mining earn more than the minimum wage[18] compared to 24.2% on average in other sectors. These results are also confirmed by the analysis reported in Table 31. Respondents who work in mining are significantly more likely to report higher income levels (Column 1) and lower chances of being deprived (Column 3). Moreover, they also tend to report an increase in income (Column 2) and an improvement in livelihoods (5) since the mine opened compared to those working in other sectors. All these results are significant at the 0.01 level except for the deprivation index which is at the 0.1 level. Most interviewees, whether they worked for the mines or not, agreed that mining employees have access to higher salaries and benefits, compared to other types of industries and jobs. Some employees live in apartments or houses reserved for staff. Others were supported by their land purchased for residential purposes. For all employees without independent means of transportation, buses are organised.

There was a consensus among interviewees with respect to the direct and indirect employment impacts from LSM. More specifically, out of the 62 people interviewed about

[18] MGA200,000 at the time of the study equals around USD53.

the local economic and social impacts, only 22 outlined the positive impacts on employment at the local level. Out of those, nine work closely with the mining companies as employees, suppliers or subcontractors, organisations created as part of the CSR policy or mining authorities. The rest are mainly representatives of local and regional authorities. While the latter group underline the jobs created, they also reported that there was a significant drop of employment post-construction of the mines, that a high proportion of these jobs are temporary, often go to migrants from other regions[19] and only benefit a small number of people per fokontanys. A lack of anticipation by the state in training the local workforce to meet the demand of the mines is also highlighted as a potential reason for this by several interviewees. Recruitment policies of both mines have evolved to prioritise local recruits providing they have equivalent skills and experience. But with low numbers of people adequately trained these policies have led to a *"traffic of local residential certificates"* where migrant workers can buy such a certificate from a local fokontany to increase their chances of being recruited, reported several representatives of local authorities and mining employees. In any case, such a certificate can be obtained after three months of residence in a fokontany, which disadvantages permanent residents reported the interviewees. As for indirect jobs created, two employees at QMM asserted that *"each job created supports six other jobs*" as "*higher salaries associated with mining sector activities provide greater opportunities for mining suppliers and local spending"* (World Bank 2015b). But this enthusiasm contrasts with what those who feel "outside" of the group of beneficiaries think. *"Beyond the employees, no one else benefits from the mine",* said a shop owner along the road rehabilitated between Moramanga and the Ambatovy mine.

[19] Commitments from mining companies to recruit local but providing competences are equivalent. Some reported that it was easy to obtain a fake certificate of residence for migrants to use for them to be recruited.

Health and food security outcomes

Since QMM and Ambatovy are operated by international mining companies, they are subject to implementing high standards of health and safety procedures. Data on occupational health and safety can be obtained in the mines' respective sustainable reports. Employees have access to better and free health care and nutrition with the canteen on site during their shifts. As expected, improved economic outcomes are associated with improved food security for people working in mining. They are more likely to have higher animal protein intake (Table 32, Column 1) and skip meals more rarely (Table 32, Column 2).

During the interviews, there was no mention of the health and safety of mining workers. However, the econometric analysis shows that mining workers are more likely to report a worse health self-assessment and a deterioration of their health since the arrival of the mines compared to other sectors (negative but not significant results). In addition, 15.0% of the mining employees in our sample said they had been injured at work and 47.4% said they were worried to very worried that their job may create health or mental injury. Given the focus on direct and indirect employees' health and safety and the significantly positive impact on economic outcomes for such workers, these results are surprising and would need to be further investigated. This result could be due to an often-observed phenomenon called the "attrition of preferences" or "self-adjusted aspirations" of those working in other sectors who are highly likely to be less privileged. Conversely, the well-off are more likely to complain, in particular in regard to health problems (Razafindrakoto, Roubaud 2006).

Social outcomes

Working for these mining companies bestows for most employees a superior social status that is immediately visible near the mines, which in Madagascar does not tend to fuel social divisions and generate conflicts as witnessed in other countries. Mining workers tend to earn more, live in more modern houses, and have gear and uniforms. The ones interviewed all displayed a sense of pride to work for the mine either directly or indirectly through the provision of services such as maintenance. Inversely, others can display high levels of disappointment if their contracts were terminated or they have never managed to work there. In the 34 fokontanys visited, the number of local inhabitants working at either of the mines was between 0 and 15 for the largest fokontanys, which *"creates a lot of frustration for people who would like to work there and get better opportunities"* asserted a local public servant. Twenty-nine of the 62 interviewees mentioned a rise in delinquency by disenchanted and unemployed youth in both areas since the arrival of the mines manifesting by stealing of gasoil and material. Most of these incidents involved mining employees and external accomplices. When caught, the sanction has been the immediate dismissal of the incriminated employees.

Mining employees reported a higher level of trust in their local community (86% vs 79%) but are more likely to have experienced a form of assault (50% vs 27%) than those working in other sectors. The latter was flagged in the literature *"unusually high salary levels (from mining) can cause inflation, inequality, social tensions"* (World Bank 2015) as it stirred up the jealousy of others. As a result, mining employees are more likely to perceive a certain level of tension or violence in their community relatively to those working in other sectors (from low to high, 91% vs 75%). Yet, mining employees did not report feeling ostracised or vilified. Former employees we interviewed were still proudly displaying the objects with the mine's logos. A fokontany leader had kept an old Ambatovy

cap, an outdated calendar and other communication material hung on the wooden walls of his office as a souvenir of his time as an employee. Mining employees reported feeling more included in the local decision-making process than those working in other sectors. For example, they thought the consultation of citizens before decision-making is well done (77.3 vs 66.4%) and 68.2% feel well informed in terms of local development and budget use (vs 52.0%). Therefore, social outcomes for mining employees are mixed: they are more likely to experience a form of assault or perceive a certain level of tension and violence but don't appear to be ostracised and vilified by the rest of their communities as it be reported in the literature about Madagascar (Mulligan 1999, Andrews Lee Trust 2009) or in other mining communities (Macdonald 2004, Meisanti et al. 2012, Narayanan 2016, Quodling 1991, Starke 2020).

5.5.3 Households that are the closest to the mines benefit less from LSM

Unexpectedly, households that are the closest to the mines (0–10 km) are doing relatively worse and have benefited less from LSM than those who live further away (11 to 15 km), in comparison to households in the 16–20 km (omitted variable).

Economic outcomes

In terms of mining revenues to "communes" (towns), who the beneficiaries are is very clear according to most of the 62 interviewees: there are the ones identified as such in the mining contracts. There are three for QMM (Smith, Shepherd and Dorward 2012b) and 20 for Ambatovy (Ambatovy 2018). As a result, some representatives of local authorities found it unfair that their commune was not on the list of beneficiaries despite their proximity to the mine. Others added that the level of overall benefits from the mines was highly dependent on the quality of the governance and accountability of local mayors.

As for household economic outcomes, interviewees had the intuition that *"those closer to the mine benefit more from direct and indirect jobs but also from training opportunities"* (asserted a mining expert). However, the econometric analysis shows that those in the 0–10 km area is less likely to have benefited less from LSM than those in the 11–15 km area compared to households in the 16–20 km area (omitted variable). Indeed, Table 31 show that households in the 11–15 km area are more likely to report a higher income since the arrival of the mines (Column 1), whilst living in the 0–10 km radius is associated with higher chances of having experienced a drop in income (Column 2). Both results being significant at the 0.1 level. These results were explained by interviewees and survey respondents by the loss of arable land, restricted access to natural resources and overall disruption caused by the mines for those in the 0–10 km radius. Some 60.6% of respondents in the 0–10 km radius reported *"more difficult access to natural resources from the forest and or the ocean since the arrival of the mine"* relative to 54.8% further away. Yet, interviewees also outlined improvements in livelihoods thanks to both mines in terms of infrastructure, access to basic services, and occupational training, entrepreneurship and education for those living near the mines. This is reflected in Column 5 of Table 31 that shows that those up to 15 km of mine are more likely to report an improvement in livelihood than those who are further away (16–20 km being the omitted variable).

Health and food security outcomes

The comparison of health and food security outcomes for communities living within 0–10 and 11–15 km gives similar results than the economic ones: households in the 11–15 km area have better outcomes, as shown in Table 32.

Health-wise, households in the 0–10 km radius are associated with bad health (Column 3) and worse health (Column 4), while those in the 11–15 km radius are more likely to have good health (Column 3) and significantly more susceptible to have seen their health improve (Column 4) since the mine arrival. In terms of food security, both groups of households are less likely to skip meals (Column 2) but those in the 0–10 km radius report higher likelihood of having experienced a decrease in animal protein intake. Nine out of 62 interviewees pointed out that the health of communities near both mines had decreased as a consequence of water and air pollution manifesting in respiratory issues. One interviewee noted the increase in birth defects near QMM since the mine arrival. Yet, health statistics were obtained from the CSBs around QMM and do not reveal any major increase in illnesses that could be related to mining activities. When asked if there were any proven links between mining operations and illnesses, most interviewees responded that there is no reliable data available at this stage on this matter. However, an anthropologist who has dedicated years to the study of the area confirmed the *“obvious psycho-social impacts the arrival of the mine may have had on locals*” that could have an impact on their health and mental health but remains unproven. It is worth noting that 80.9% of those living the closest to both mines now report having access to a Basic Health Care Centre (“Centre de Santé de Base” or CSB in Madagascar) within 30 minutes of their home compared to before the arrival of the mines (53.6%). This is the largest increase of access to CSBs. It is worth noting that households living the closest to the

mines were the ones with the lowest rate of access before the arrival of mines (0–10 km: 53.6%, 11–15 km: 62.5%, 16–20 km: 71.6%).

Social outcomes

Households that are the closest to both mines are more likely to experience assaults and trust local authorities less (see Table 33).

More specifically, households up to a distance of 15 km to the mine are more likely to report lower levels of violence and tensions (Column 1) within the community compared to those leaving further away. This result is significant at the 0.1 level for those in the 0–10 km radius. Several interviewees mentioned efforts to secure the surroundings of the mine, citing previous disruptions that ended up being costly for both mines. Yet, these households are more likely to report significantly higher numbers of assaults in the past year (Column 2). The coefficient of this OLS regression is 3.8 times higher than for households in the 11–15 km radius and significant at the 0.01 level. This may be due to their proximity to the main cities (Moramanga for QMM or Toalagnaro for QMM, at 0.01 level) and to delinquency mainly fuelled by frustration and the lack of opportunities.

> *“People are getting frustrated. These big companies arrive, and we get close to nothing. Our people and especially our youth have no opportunities. They end up stealing petrol from the mine and reselling it” (Fokontany leader near Ambatovy)*

Finally, the likelihood of trusting local authorities is lower in the 0–10 km radius and higher in the 11–15 km radius. This is not surprising, given the dissatisfaction that was conveyed during some interviews about how some groups of these mining communities had felt left out of consultation processes and misrepresented. Interestingly, the level of trust around

the mines remains higher than the national average of 24.4% (Rakotomanana et al. 2016).

5.6 Robustness checks

The robustness checks were conducted first by testing the proportional odds assumption for categorical variables and then by ensuring endogeneity doesn't impact the coefficient estimates. The results of the proportional odds test using the omodel command are presented under tables 31 to 33. Omodel produces the same results as oprobit but it also reports an approximate likelihood-ratio test of whether the coefficients are equal across categories (Wolfe 1997). The null hypothesis is that there is no difference in the coefficients between models and the results are not significant. Therefore, the variables Income change, Health level, Level of tension and violence, and Trust level in the community do not pass the proportional odds assumption test. This can be explained by the fact that our sample is mirroring some key characteristics of the population in Madagascar. More specifically, most people in Madagascar earn less than the minimum wage (see Background section 3.2), they rate their health as satisfying to very good due to the phenomenon of self-adjusted aspirations (see p. 156) and trust their local community more than national authorities (Rakotomamonjy et al. 2014). The literature also shows that the perceived level of tension and violence is higher than in most sub-Saharan countries and is not correlated to the actual experience of violence (Razafindrakoto et al. 2017, p. 118).

To ensure that endogeneity doesn't impact the coefficient estimates, an instrument variable method would be appropriate. However, this would require identifying suitable instruments. More specifically, the instruments must satisfy three conditions: they must themselves satisfy orthogonality conditions; they must exhibit meaningful correlations

with the endogenous variable; and they must be properly excluded from the model, so that their effect on the outcome variable is only indirect (Baum & Schaffer 2012). Appropriate instruments were not available for this study. To overcome this problem, it adopts the Lewbel approach to endogeneity. This method identifies parameters in regression models with endogenous or mismeasured regressors in the absence of traditional identifying information, such as external instruments or repeated measurements. Identification is achieved by having regressors that are uncorrelated with the product of heteroskedastic errors, which is a feature of many models where error correlations are due to an unobserved common factor (Baum & Schaffer 2012). To this effect, the Lewbel (2012) 2 Stage Least Square (2SLS) model approach was used in STATA with the ivreg2h command. The results presented in tables 34, 35 and 36 were obtained with (Mining 0-10km 11-15km=) being instrumented for each outcome variable. These results are aligned with those obtained without the generated instruments. For example, working in mining is also associated with higher level of income at the 0.01 level (Table 34, Column 1) and to an increase in wage at the 0.05 level (Table 34, Column 2). Inversely, living in the surroundings of QMM is associated with a decrease in income level (Column 2), a higher chance of being deprived (Column 3), a higher deprivation score(Column 4), and a worsening of livelihood (Column 5). Those living near QMM still have higher chances of having higher income levels at the 0.05 level (Column 1).

Furthermore, this robustness test is also mostly validated by the results obtained with the Underidentification test, Weak identification test and Sargan statistic). The Underidentification test (Anderson canon. Corr. LM statistic) is satisfied with $p = 0.00$ for all regressions, demonstrating that that the 2 Stage Least Square (2SLS) model is identified implying that the relationship between the instrumental variable and the instruments is sufficiently strong to justify inference from the results (Herrnson, Morris &

Mctague, 2011). However, none of the specifications pass the weak identification test (Cragg-Donald Wald F statistic) since their respective *F* values are smaller than the critical values obtained with the Stock–Yogo weak ID test, indicating that our instruments are weak (Stock & Yogo 2005). This is likely to be due to the low number of instruments employed (3) for a sample of up to 730 individuals according to Murray (2006). “Weak identification” arises when the excluded instruments are correlated with the endogenous regressors, but only weakly (Stock & Yogo 2005). The values obtained for the Stock and Yogo tests at 5, 10, 20 and 30% and in size 10, 15, 20, 25% are close to the critical values in Yogo’s table. Therefore, these results are considered as acceptable (Skeels & Windmeijer 2018). Finally, all regressions satisfy the Sargan test with $p > 0,05$ meaning that the null hypothesis; that is, the restrictions on the coefficients are valid and our model is correctly specified and cannot be rejected. The group of instruments used in the analysis are validly exogenous (Lee, Okui & Haven 2009). Thus, the results obtained are robust and our findings valid.

Table 34: Detailed results of Lewbel's method using ivreg2h to generate IV applied to economic dependent variables

	(1) Income level	(2) Income change	(3) Deprivation MPI index	(4) Deprivation MPI score	(5) Livelihood change
	Low to high	*Decrease to increase*	*Deprived or not deprived*	*Deprived to not deprived*	*Worse to improve*
	OPROBIT	OPROBIT	PROBIT	OLS	OPROBIT
0 to 10 km	0.089	-0.094	0.111	0.082***	0.004
	(0.150)	*(0.163)*	*(0.083)*	*(0.029)*	*(0.159)*
11 to 15 km	0.115	-0.224	-0.078	0.013	-0.135
	(0.181)	*(0.193)*	*(0.101)*	*(0.036)*	*(0.191)*
In the vicinity of QMM	0.148**	-0.392***	-0.355***	-0.153***	-0.432***
	(0.064)	*(0.068)*	*(0.036)*	*(0.013)*	*(0.068)*
Working in mining	0.602***	0.508**	0.061	-0.043	0.218
	(0.187)	*(0.200)*	*(0.106)*	*(0.037)*	*(0.202)*
Partnered relationship	0.145**	0.166***	0.092***	0.027**	0.144**
	(0.060)	*(0.064)*	*(0.033)*	*(0.012)*	*(0.065)*
Having dependents	0.030***	-0.024**	-0.000	-0.003	-0.003
	(0.011)	*(0.011)*	*(0.006)*	*(0.002)*	*(0.011)*
Studied beyond secondary	0.472***	0.218**	0.168***	0.086***	0.288***
	(0.096)	*(0.101)*	*(0.053)*	*(0.019)*	*(0.102)*
Primary highest education	0.138	0.078	0.043	0.031*	0.066
	(0.091)	*(0.096)*	*(0.050)*	*(0.018)*	*(0.097)*
At least 6 years of schooling	-0.060	0.011	0.390***	0.228***	0.009
	(0.069)	*(0.073)*	*(0.038)*	*(0.014)*	*(0.074)*
Being self-employed	-0.146	0.108	0.037	0.061**	0.397**
	(0.164)	*(0.170)*	*(0.085)*	*(0.030)*	*(0.169)*
Being employed	0.151	0.245	0.076	0.077***	0.464***
	(0.161)	*(0.168)*	*(0.084)*	*(0.030)*	*(0.165)*
Working in artisanat	-0.211	-0.034	-0.090	-0.096***	-0.177
	(0.137)	*(0.149)*	*(0.077)*	*(0.027)*	*(0.150)*
Working in primary sector	-0.160	-0.099	-0.083	-0.035	-0.256**
	(0.119)	*(0.129)*	*(0.067)*	*(0.024)*	*(0.130)*
Working in services	0.006	0.108	0.048	-0.008	-0.045
	(0.114)	*(0.123)*	*(0.064)*	*(0.023)*	*(0.124)*
Constant	1.074***	2.023***	0.196**	0.439***	1.814***
	(0.193)	*(0.198)*	*(0.097)*	*(0.034)*	*(0.196)*
Observations	695	697	730	730	706
R-squared	0.207	0.169	0.422	0.592	0.163

Notes: Standard errors in parentheses. All columns show the results obtained with ivreg2h and generating instruments for (Mining 0-10 km 11-15km=). The focus of the analysis is on the sign and level of significance of the coefficients of the explanatory variables (0-10 km, 11-15 km, in the vicinity of QMM and Working in mining). The sign goes from negative to positive and is aligned with the nature of the outcome. Column 1 shows results with Income level as dependent variable. Column 2 shows results with Income change as dependent variable. Column 3 shows results with Deprivation MPI index as dependent variable. Column 4 shows results with Deprivation MPI score as dependent variable. Column 5 shows results with Livelihood change as dependent variable. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 35: Detailed results of Lewbel's method using ivreg2h to generate IV applied to health and food security dependent variables

	(1) Protein intake change	(2) Meals skipped frequency	(3) Health Level	(4) Health level change
	Low to high intake	*Often to never*	*Very bad to very good*	*Worsen to improved*
	OLS	PROBIT	OPROBIT	PROBIT
0 to 10 km	-0.632	-0.012	-0.169	-0.125
	(1.698)	(0.108)	(0.224)	(0.130)
11 to 15 km	2.138	0.113	-0.038	-0.005
	(1.305)	(0.083)	(0.177)	(0.104)
In the vicinity of QMM	2.488	0.064	-0.274	-0.092
	(1.598)	(0.103)	(0.214)	(0.126)
Working in mining	-7.140***	-0.401***	-0.419***	-0.269***
	(0.575)	(0.036)	(0.076)	(0.045)
Partnered relationship	0.672	0.034	-0.019	-0.061
	(0.538)	(0.034)	(0.070)	(0.041)
Having dependents	0.149	-0.004	0.014	-0.005
	(0.095)	(0.006)	(0.013)	(0.007)
Studied beyond secondary	-0.236	0.116**	-0.038	-0.120*
	(0.869)	(0.054)	(0.112)	(0.065)
Primary highest education	-1.170	0.086*	-0.171	-0.154**
	(0.825)	(0.051)	(0.106)	(0.062)
At least 6 years of schooling	0.768	0.053	0.169**	0.062
	(0.627)	(0.039)	(0.081)	(0.048)
Being self-employed	2.821**	0.104	0.514***	0.359***
	(1.375)	(0.087)	(0.181)	(0.105)
Being employed	2.689**	0.121	0.498***	0.294***
	(1.349)	(0.085)	(0.178)	(0.103)
Working in artisanat	-1.123	-0.072	-0.374**	-0.225**
	(1.248)	(0.080)	(0.164)	(0.096)
Working in primary sector	-1.656	0.019	-0.220	-0.268***
	(1.082)	(0.069)	(0.142)	(0.083)
Working in services	-0.971	0.053	-0.208	-0.111
	(1.032)	(0.066)	(0.136)	(0.080)
Constant	-2.963*	0.605***	2.177***	0.714***
	(1.551)	(0.098)	(0.206)	(0.120)
Observations	718	725	730	715
R-squared	0.234	0.248	0.089	0.116

Notes: Standard errors in parentheses. All columns show the results obtained with ivreg2h and generating instruments for (Mining 0-10 km 11-15km=). The focus of the analysis is on the sign and level of significance of the coefficients of the explanatory variables (0-10 km, 11-15 km, in the vicinity of QMM and Working in mining). The sign goes from negative to positive and is aligned with the nature of the outcome. Column 1 shows results with Protein intake as dependent variable. Column 2 shows results with Meals skipped frequency as dependent variable. Column 3 shows results with Health level as dependent variable. Column 4 shows results with Health level change as dependent variable. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 36: Detailed results of Lewbel's method using ivreg2h to generate IV applied to social dependent variables

	(1) Level of tension and violence	(2) Number of assaults	(3) Trust level in the community
	Low to high	Low to high	Low to high
	OPROBIT	OLS	OPROBIT
0 to 10 km	-0.054	0.796	-0.068
	(0.177)	(0.537)	(0.171)
11 to 15 km	0.184	0.169	0.101
	(0.216)	(0.650)	(0.204)
In the vicinity of QMM	0.113	0.536**	0.095
	(0.074)	(0.229)	(0.072)
Working in mining	0.027	-0.347	0.272
	(0.221)	(0.679)	(0.213)
Partnered relationship	0.037	-0.003	-0.210***
	(0.070)	(0.212)	(0.067)
Having dependents	-0.001	0.031	0.001
	(0.012)	(0.038)	(0.012)
Studied beyond secondary	0.280**	0.711**	-0.076
	(0.111)	(0.339)	(0.107)
Primary highest education	0.228**	0.113	-0.135
	(0.105)	(0.321)	(0.101)
At least 6 years of schooling	-0.051	-0.114	0.042
	(0.081)	(0.247)	(0.078)
Being self-employed	0.281	0.203	0.056
	(0.178)	(0.549)	(0.172)
Being employed	0.391**	0.725	-0.106
	(0.176)	(0.539)	(0.170)
Working in artisanat	-0.131	-0.576	-0.177
	(0.161)	(0.498)	(0.157)
Working in primary sector	-0.170	-0.290	0.056
	(0.140)	(0.431)	(0.135)
Working in services	-0.180	-0.379	-0.169
	(0.134)	(0.411)	(0.129)
Constant	1.731***	-0.055	2.468***
	(0.203)	(0.623)	(0.197)
Observations	718	730	721
R-squared	0.011	0.050	0.042

Notes: Standard errors in parentheses. All columns show the results obtained with ivreg2h and generating instruments for (Mining 0-10 km 11-15km=). The focus of the analysis is on the sign and level of significance of the coefficients of the explanatory variables (0-10 km, 11-15 km, in the vicinity of QMM and Working in mining). The sign goes from negative to positive and is aligned with the nature of the outcome. Column 1 shows results with the intensity of Tension and violence as dependent variable. Column 2 shows results with Number of assaults as dependent variable. Column 3 shows results with Trust level as dependent variable. ***p < 0.01, **p < 0.05, *p < 0.1.

5.7 Conclusion

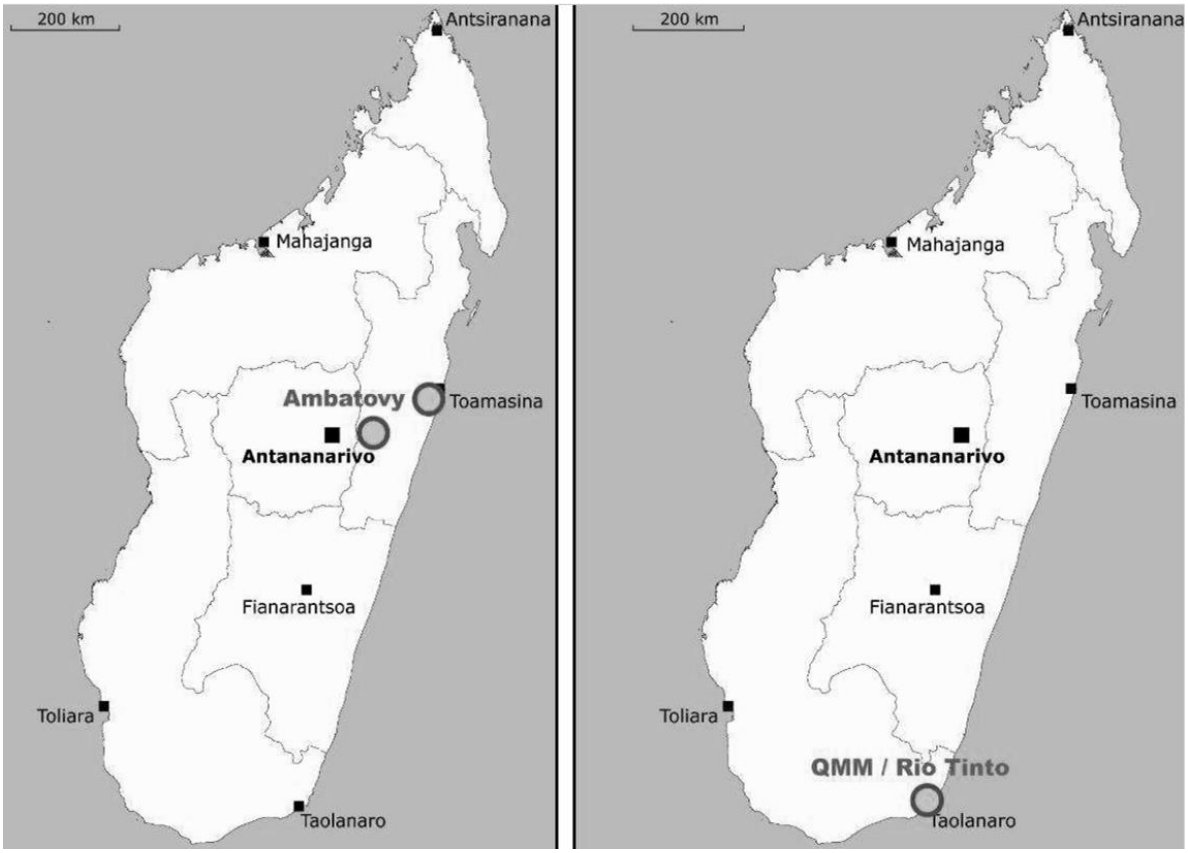
As expected, communities near Ambatovy have experienced better outcomes than those near QMM due to better pre-existing conditions, fewer people being affected by the mining operations, and a larger investment, which raises the question of an investment threshold linked to a disruption scale and the poverty level of the mining area. In addition, working in mining – either directly or indirectly – leads to much better outcomes, especially economic ones. The coefficients of the regressions on health and social outcomes are not significant but descriptive statistics and interviews confirmed the privileged situation of mining workers. Yet, working for the large multinational companies doesn't seem to create social divisions unlike in other countries, which is extremely positive compared to peer sub-Saharan countries where resources have been at the core of civil conflicts. This would need to be closely monitored over time, especially as the rise in inequalities may lead workers to feel more unsafe and to separate themselves more from their community. Finally, and most surprisingly, those who are the closest to the mines are not those who benefit the most partly because of the impact on land, access to resources, pollution and the overall scale of disruption. Those who seem to fare better are those in the 11–15 km radius, providing they have access to a main road.

Therefore, more efforts need to be made by both mining companies, and local and central authorities, to further support these improvements and address the limitations in the benefits of 15 years of LSM. More specifically for youth, women and those in agriculture, fishing, craftsmanship and forestry. Yet, changes are underway to enable communities to further benefit from mining revenues. A local treasury office (Trésorerie Principale Inter-communale or Main Inter-municipality Treasury) is bound to open in Toalagnaro and will aim to enhance the control and monitoring of local spending from mining revenues, similarly to the one in Moramanga opened in 2017. This will foster more adequate

investments for the local population. However, at the time of the fieldwork only a few communes in the vicinity of QMM had a local development plan (Plan Communal de Développement or PCD) that had been developed in the past five years. Most of them were outdated, not taking into account population growth or the presence of the mine. As part of its strategy to develop its local area in a consultative way, Ambatovy has financially supported the development of new PCDs to reflect these changes, but for QMM employees this type of initiative goes beyond the scope of their mission of *"We are a private company, not a CSO"* according to several interviewees there. The question of the legitimacy of mining companies in these processes of use of mining revenues is central in the thinking of how large-scale mines could further foster economic and social development.

Appendix 5.1: Map of Ambatovy and QMM mines

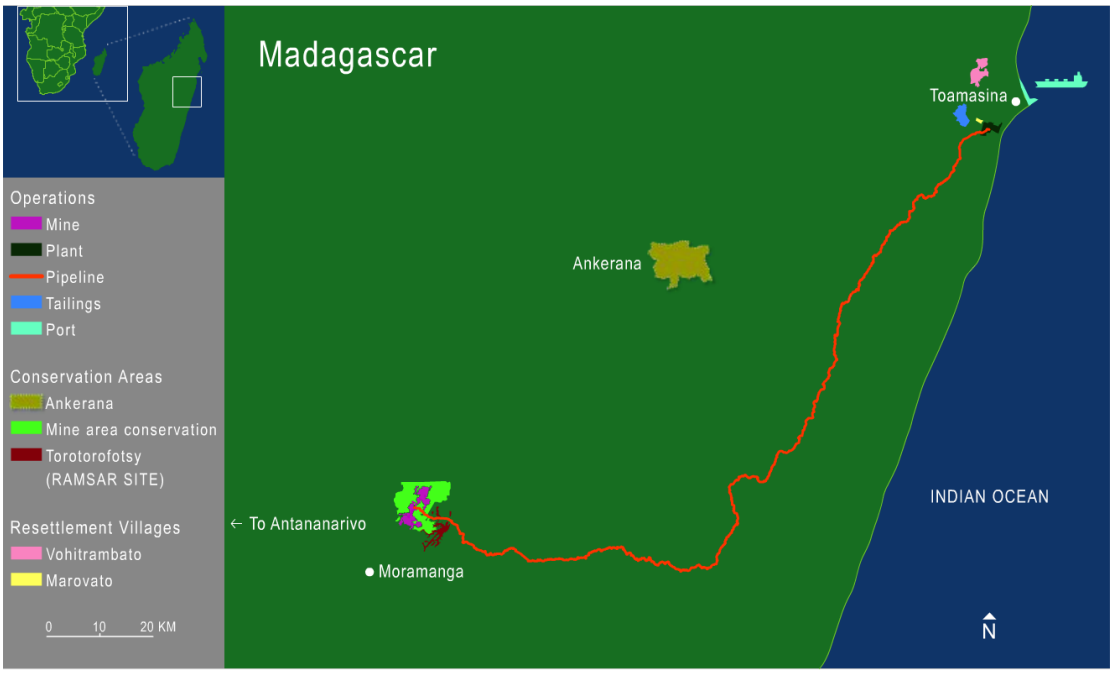
Map 9: Map of Ambatovy and QMM mines



Source: Friends of the Earth 2013

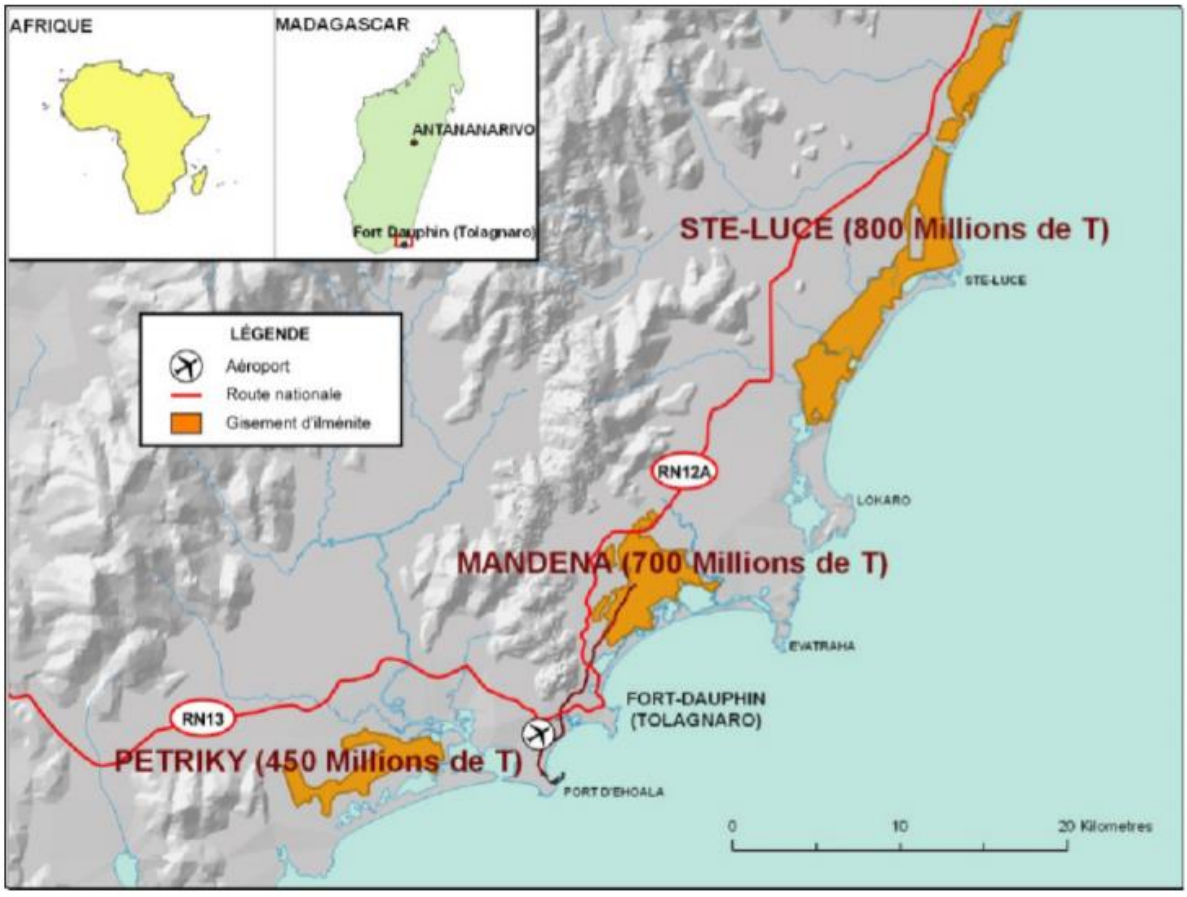
Appendix 5.2: Ambatovy – Mine site, pipeline, and plant site

Map 10: Ambatovy: Mine site, pipeline, and plant site



Source: Ambatovy http://www.ambatovyfiles.net/files/carte/carte.html

Appendix 5.3: QMM mine site (Mandena) and extensions



Source: Swanson 2019 for Andrew Lees Trust

Appendix 5.4: Household surveys

ENQUETE INDIVIDUELLE – COMMUNAUTES MINIERES ECRIRE EN LETTRES MAJUSCULES						
SECTION 1 – Identification du questionnaire (IQ)						
IQ1	Nom de l'enquêteur *Anaran'ny mpanadihady*					
IQ2	Code du questionnaire *Kaodin'ny fanontaniana*	|_|_|_|_||_|_||_|_| DDate *Daty*	|_||_||_||_| Heure de début *Ora nanombohana*	|_| Site – fokontany *Toerana – Fokontany*	|_| N° de l'enquêteur *Laharan'ny mpanadihady*	
IQ3	Site de l'enquête – fokontany/village *Toeran'ny fanadihadiana – Fokontany*				Indiquer le code fokontany	|__|
IQ4	Site de l'enquête – commune *Toeran'ny fanadihadiana – Kaominina*				Indiquer le code commune	|__|
IQ5	Site de l'enquête – région *Toeran'ny fanadihadiana – Faritra*		1: Alaotra Mangoro 2: Anosy			|__|
IQ6	Coordonnées GPS du ménage *Teboka GPS n'ny tokatrano*		Latitude……..Longitude……..			
IQ7	Distance de la mine *Elanelana amin'ny toeram-pitrandrahana*		1: 0–10 km 2: 10–20 km			|__|
IQ8	Durée de l'entretien *Faharetany*		|__|__|h |__|__|min			
IQ19	Sexe *Lahy na Vavy*		1: Masculin (*Lahy)*	2: Féminin (*Vavy)*		|__|
IQ10	Type d'habitation/*Karazan'ny trano fonenana*		1: Mur en brique et toit en tôle/ R indrina biriky sy tafo fanitso 2: Mur en brique et toit en chaume/ *Rindrina biriky sy tafo bozaka* 3: Mur en bois et toit en tôle/ *rin drina hazo sy tafo fanitso*	4: Mur en bois et toit en chaume/ *r indrina hazo sy tafo bozaka* 5: Mur en terre battue et toit en t ôle/ *Rindrina ampehin-tany sy tafo fanitso* 6: Mur en terre battue et toit en c haume/ *rindrina ampehin-tany sy tafo bozaka* 7: Autre/ *hafa*		|__| *Si 7, préciser*: *Raha 7 dia inona* _____ _____ _____ ___
IQ11	Statut de l'enquête *Mahakasika ny fanadihadiana*		1: rempli complétement *Feno daholo*	2: rempli partiellement *Misy tsy fen o*		|__|
IQ12	Auto-évaluation de la fiabilité des informations/réponses *Fahitanao ny valinteny*		1: Information fiable *Azo itokiana*	2: Information non fiable *Tsy dia azo itokiana*	3: Pas d'opinion *Tsy manan-kevitra*	|__|
IQ13	Commentaires de l'enquêteur sur les conditions de déroulement de l'enquête *Fanamarihana momba ny fizotry ny fanadihadiana*					
SECTION 2 -Critères de sélection (CS)						
CS1	Quel âge avez-vous ? *Firy taona ianao ?*		Indiquer le nombre d'années *Soraty ny isan'ny taona*			|__|__| ans *Si < 18 ans – FIN*
CS2	Depuis quand vivez-vous dans cette commune ? *Hatry ny oviana ianao no nonina tanat n'ny Kaominina?*		Indiquer l'année *Soraty ny taona*			|__|__|__|__| *Si après 2005 – FIN*
CS3	Combien d'années vous avez vécu dans cette commune ? *Hatramin'ny 2005, firy taona no niainnao t natin'ny Kaominina ?*		Indiquer le nombre d'années *Soraty ny isan'ny taona*			|_||_| *Si < 10 ans – FIN*
CS4	Quel est votre situation dans la famille ? *Inona no toeranao anatin'ny tokatrano ?*		1: Adulte du ménage *(Olondehibe ato antrano)* 2: Parent en visite *(Havana mandalo)* 3: Enfant *(Zanaka)*			|__| *Si 2 ou 3 – FIN*

SECTION 3 – Identification'enquêt (IE)			
IE1	Quelle est votre nationalité ? *Teratany avy aiza ianao?*	1: Malgache (Malagasy 2: Autre, préciser	|__| Si 2 préciser et passer à *IE3* _____
IEl est votre lieu de naissance ? *Taiza no toerana nahaterahanao?*		Région / *Faritra*	| _|
		Commune/ *Kaominina*	_____ _
IE3	Où vivez-vous actuellement ? *Monina aiza ianao izao ?*	1: dans un logement qui es votre propriété (*Trano nay manokana tsy hofaina)* 2: dans un logement loué (*Trano hofaina)* 3: dans un l ogement fourni par votre employeur (*Trano n omen'ny mpampiasa)* 4: chez un proche (*Amin'olona akaiky ahy)* 5: sur le li eu de travail (*Ao amn'ny toeram-piasako)* 6 : Autre / *Hafa* 7: NSP/PDR	|__| *Si 6, préciser*: _____
IE4	Quel est votre siuation matrimoniale ? *Ny momba ny fiainanao manokana*	1: Célibataire /*Tokan- ena* 2: En relation / *Miaraka amin 'olona* 3: Marié (e) / *Manam bady* 4: Divorcé (e) / *Nisara-bady* 5: Veuf/ve / *Maty vady* 6: Autre / *Haf€*__| *Si 6, pré ciser*: _____	

IE5	Avec combien de personnes vivez-vous ? *Firy ianareo no miray trano ?*	Indiquer le nombre de p rsonnes *Isan'ny olona*		|__|
IE6	Avez-vous des personnes à charge ? *Manana olonomina ve ianao?*	1: Oui (*Eny)* 2: N n (*Tsia)* 3: NSP-PDR		|__|
IE7	Si oui, combien* *Rah a eny, dia firy ?*	1: Enfant *zanaka* 2: Partenaire / conjoint / *Vady , Nam ana* 3: Autre parent (s) / *Havana* 4: Autre / *Hafa*		|__| |__| |__ | *Si 4, préciser*: _____ __
IE8	Quel est votre niveau d'étude?/ *Inona ambaraa vitanao farany?*	1: Jamais scolarisé (*Tsy mbola nianatra mihintsy)* 2: Ecole primaire (*Ambaratonga voalohany)* 3: Etudes secondaires (*Ambaratonga faharoa)* 4: Etudes supérieures (*Fianarana ambony)* 5: NSP-PDR		|__|
IE9	Est-ce qu'il y a des membres du ménage de plus de 13 ans n'ont pas fait au moins six années d'études ? si Oui, combien ? /*Misy olona mihoatra ny 13 taona ve TSY niana ra mihoatra ny en na taona ? raha misy dia firy ?*	Indiquer le nombre de personnes *Soraty Isa 'ireo olona*		|__|
IE 0	Combien d'enfants entre 6 et 16 ans dans le ménage ne fréquentent pas l'école ? *Misy firy ny zaza 6 ka hatramin'ny 16 taona tsy mianatra?*	Indiquer le nombre d'enfants *Soraty Isan'ireo zaza*		|__| *Si 0 passer a IE11*
IE10 bis	Quelle est la raison principale pour la quelle ils ne vont pas à l'école ? /*Azo fantarina ve ny antony manokana tsy hianaran'izy ireo ?*	1: Pr blème d'argent/ *Olana ara-bola* 2: Pas d'école à proximité/ *sy misy sekoly akaiky* 3: Ils refusent d 'y aller/ *Tsy mety handeha zareo* 4: Maladies / *Areti na* 5: Ils travaillent (aux champs ou ailleurs)/ *Mi asa zareo (eny an-tsaha na toeran-kafa)* 6: Autre/ *Hafa*		|__| *Si 6, préciser*: _____
IE11	Quelle est votre catégorie socio-professionnelle ?	Salarié 1: Cadre supérieur, ingén eur, autre 2: Cadre moyen, agent de maîtrise 3: Employé, ouvrier qualifie 4: Employé, ouvrier semi-qualifie 5: Manœ uvre	Non salarié 6: Patron/ *P atron* 7: Propre compte/ *Miasa tena* 8: Apprenti/ *Mpianatr'a sa* 9: Aide familial/ *Mpanampy*	|__|

IE12	Qui est l'employeur actuel de votre emploi principal? *Iza nopiasa anao izao*	1: Administration publique/ *Asam-panjakana* 2 : Entreprise (para)publique *O rinasa miankina* 3: Autre entreprise privée *Orinasa tsy miankina*	4: Ambatovy 5: Entrepri se associative/ *Fikambanana* 6: Ménage/ *Tokantrano* 7: Autre/*He fa*	|__| *Si 7, préciser*: _____
IE13	Est-ce que l'entreprise de votre emploi principal est enregistrée au registre du commerce ou au CNaPS? *Misoratra CnaPS ve ianao amin'ny asanao izao? ary manana rejisitra ara-bar otra ve ny mpampiasa anao?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR		|__|
IE14	Dans quel secteur est votre activité principale ? *Inon a no sehatry ny asanao ?*	1: Agriculture / *Fambolena* 2: Elevage/ *iompiana* 3: Pêche/ *Jono* 4: Entretie n de forêts/ *Fikajiana ny al a* 5: Construction / *Fa norenana* 6: Fab rication/ *Fanamboarana* 7: Juridique/ *Lalà na* 8: Santé/ *Fahasalamana* 9: Banque / Finance / Assurance/ *Banky isankarazany* 10 : Communication / *techn ologie* 11: Commerce / détail/ *Varotra* 12: Industrie minière/ *Fitrandrahana harena an kibon'ny tany* 13: Pétrole / gaz/ *Solika sy Gaz* 14: Restauration/hôtellerie/ *Hotely sy fandra isambahiny* 15: Travail pour des m énages / Garde d'enfants / *Miasa antrano na mpitaiza zaza* 16: Services personnels (coiffeur, chauffeur de taxi, etc.) / *Asa tena* 17: Aut re/ *Hafa*		|__| *Si 17, préciser*: *Raha 17 dia inona* _____ _____ _____
IE15	Quel est votre métier principal? *Inona no asanao amin'izao ?*	Indiquer métier		_____ _____ ____ _____ ____
IE16	Avez-vous une activité primaire et secondaire ? *Manana anton'asa hafa faharoa ve ianao ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3 NSP-PDR		|__| *Si 2,3 passer à ISE1*
IE17	Dans quel secteur est votre activité secondaire *a eny dia inona ny sehatra misy ny anton'asanao faharoa ?*	Indiquer code sect ur *Soraty ny kaodin'nilay sehatra*		|__|
IE18	Quel est votre métier secondaire? *Inona ilay asanao faharoa ?*	Indiquer r		_____ _____ _____ _____ ____
SECTION 4 – Impact Sur l'Emploi (ISE) **AIDER L'ENQUETE A SE REMEMORER 2005 – l'année du début de la construction de la mine en 2005**				
ISE1	Depuis combien de temps exercez-vous votre métier principal? / *Hafiriana no nanaovanao io asa io?*	Indiquer la durée/*Lazao ny faharetany*		|__|__| ans |__|__| mois
ISE2	Avez-vous occ upé un autre métier avant ? *Efa nanana asa hafa ve talohan'izao ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: Pours ite d'étude/formation/ *Nanohy fianarana* 4: NSP-PDR		|__| *Si 2,3,4 passer à ISE5* *Raha 2,3,4,dia tonga dia ISE5*
ISE3	Quel métier faisiez-avant ? *Inona ny asanao talohan'izao ?*	Indiquer métie/*Soraty ilay asa*		_____ _____ _____ _____ ___
ISE4	Est-ce que ce changement de métier principal a été causé par l'arrivée de la mine ?/*Vokatry ny Fitrandrahana io ve no nanovanao asa ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR		|__|

ISE5	Dans votre localité, est-ce qu 'il y a plus ou moins d'opportunités d'emploi ? *sy fanantenana hahazo asa ve eto aminareo ?*	1: Il y a plus d'opportunités d'emploi /*Misy fanantenana* 2: Pas de changement au ni eau de l'emploi/*tsisy fiovana* 3: Il y a moins d'opportunités d'emploi/*kely ny fanantenana* 4: NSP-PDR	|__| *Si 2,4 pass er à ISE7*
ISE6	Dans quel secteur ?/*Sehatra inona ?*	Indiquer code secteu*aty ny sehatra*	|__|
ISE7	Est-ce que les hommes ou les femmes ont plus susceptibles de trouver du travai*y lahy sa ny vavy no mora mahita asa ?*	1: Les hommes/*Lahy* 2: Les femmes/*Vavy* 3: NSP-PDR	|__|
ISE8	Quels secteurs ont le plus bénéficié de l'arriv ée de la mine ?*/*Ny sehatry ny ino nahita tombotsoa kokoa amin'io fitrandrahana io ?*	Indiquer code sec eurs *Soraty ny kaodin'nilay sehatra*	|__||__| |__||__| |__||__|
ISE9	Quel secteurs ont le plus souffert de l'arrivée de la mine ?*atra nijndra noho ny fisian'io fitrandrahana io ?*	Indiquer code secteur *Sorat ny kaodin'nilay sehatra*	|__||__| |__||__| |__||__|
SECTION 5 – Impact sur la Qualité de Vie (IQV)			
V1	Avez-vous eu une blessure accidentelle, une maladie, un handicap ou tout autre problème de santé physique ou mental causé par le travail?/*Efa nahazo ratra na aretina na takaitra na olana ara-batana na ara-tsaina noho ny asa ve ianao ?*	1: Oui (*Eny)* 2 : Non (*Tsia)* 3: NSP-PDR	|__|
IQV2	Dans quelle mesure êtes-vous inquiet(e) par le fait que votre travail puisse vous causer des dom mages physiou mentaux?/*Tsapanao na miahiahy ve ianao fa€ asanao dia mety hiteraka olana ara-batana na ara-tsaina ho anao ?*	1: Pas inqui et(e)/*Tena tsy miahiahy* 2: Pas trop inquiet (e)/ *Tsy dia miahiahy loatra* 3: Assez inquiet (e)/ *Miah ahy kely* 4: Très€quiet (e)/*Tena ma nahy* 5: NSP-PDR	|__|
TOUS – Depuis l'arrivée de la mine en 2005			
€3	Comment l'accès aux plantes médicinales à change? (ex. talapetraka, satrikoaga maratra)/*Nisy fiovana ve ny fahafahana mampiasa ny raokandro teto an-toerana ?*	1: L'accès est plus facile/*Niha mora* 2: Même niveau d'acces/ *Tsy niova* 3: L'accès est plus difficile/*La a s arotra* 4: NSP-PDR	|__|
IQV4	Est-ce qu e l'accès aux ressources naturelles de la forêt a changé ?/*Nisy fiovana ve ny fahafahana msa ireo harena voajanahary anaty ala ?*	1: L'accès est plus facile/*Niha m ra* 2: Même niveau d'acces/ *Tsy niova* 3: L'accès est plus difficile 4: N P-P DR/ *Lasa sarotra*	|__|
IQV5	Est-ce que a pratique des coutumes locales a changé ? *Nisy fiovana ve ny fo mba nentim-paharazana tet*:	1 : Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR	|__| *Si 2 ou 3, passer à IQV7*
IQV6	Qu'est-ce qui a changé ?*/*Inona n o niova ?*	1: De s tombes sacrées ont été détruites/*Nisy fasana simba* 2: Des poteaux sacrés «Tsikafana ont été détruits *Tsik afana na tsangambato simba* 3: Les traditions religieuses n e peuvent plus être observées/*Tsy voahaja ny finoana* 4: Une grande partie de la fo rêt a disparu/*Nisy faritra ala simba* 5: Autre/*Hafa* 6: NSP-PDR	|__| |__| |__| |__| | __| *Si 5, préciser* _____ _____
IQV7	Dans votre localité, jusqu'à quel point faites-vous confiance à la plupart des gens qui vous entourent? /*Hatraiza ny fifampitokisana eo amin'ny samy mpiara-monina ?*	1: Complètement confiance /*Mifampatoky daholo* 2: Plutôt conf iance/*Eo ho eo* 3: Pas vraiment confiance/ *Tsy dia marina loa ra* 4: Pas du tout confiance/*Tsy misy fifampatokisa na mihitsy* 5: NSP-PDR	|__|

IQV8	Comment votre conseil local/communal met en pratique les actions suivantes liées à l'activité minière ?/*Ahoana noon'ny mpanolotsaina na tompon'andraikitra eto an-tanàna ny fifandraisan'ny asam-pitrandrahana an'ireto zavatr ireto?*	1: Très bien/*Tsara* 2: Plutôt bien/*Eo ho eo* 3: Plutôt mal/*ratsy* 4: Très mal /*tena ratsy* 5. NSP-PDR A. Informer les gens ordi nair es sur les programm es d'action, les revenus et les budgets/*Ampa halalainy ny vahoaka ny drafitr'asa, ny vola miditra , ny teti-bola* B. Consulter les citoyens avant la prise de décision /*Maka ny hevitry ny vahoaka vao mandray fanapahan-kevitra* C. Consulter les chefs traditionnels/de la communauté /*Maka ny hevitry ny Tangalamena* na ray amandreny ara-drazana	A|__| B|__| C|__|
IQV9	De nos jours, quel degré de tension ou de violence existe-t-il entre les différents groupes vivant dans votre localité? *ny endrika herisetra na disadisa miseho eo amin'ny tontolom-piarahamonina ankehitriny*	1. Très élevé/*Avo dia avo* 2. Plutôt/ *Misy ihany* 3. Pas vraiment /*Tsy dia misy* 4. Pas du tout /*Tsy misy* 5: NSP-PDR	|__|
IQV 10	Est-ce que l'arrivée de la mine a provoqué une augmentation des tensions entre les groupes communautaires ?/*Ny finy fitrandrahana ve nampisy disadisa sy olana ho an'ny vondron'olona isankarazany ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR	|__|
IQV 11	Pourquoi ? *Satria nahoana ?*	1: Compétition économique pour les e plo is/*Flfaninana ara -toekarena ho an' ny sehatra a* Compétition économique pour les contrat s/*Flfaninanana ara-toekarena ho an'ny fifanarahana araka asa* 3: Utilisation des revenus m iniers/ *Fampiasana ny vola miditra noho ny fitrandrahana* 4: Gestion des ressources naturelles utilisées par la mine /*Fitantanana ny harena voajanahary ampiasain'ny fitrandrahana* 5: Afflux de migrants/*Fisian'ny vahiny* 6: Autre/*Hafa* 7: NSP-PDR	|__| *Si 6, préciser* _____ _____
IQV 12	Est-ce que depuis l'arrivée de la mine, vous av ez vécu les situations suivantes ? Si oui, combien de fois ?/*Hatry ny nisian'ny Fitrandrahana, efa niaina ireto ve ianao ? Raha eny dia efa im-piry?*	1. Oui */Eny* 2. Non/*Tsia* 3. NSP-PDR A. Quelqu'un s'est introduit chez vous sans permission et a v lé ou essayé de voler quelque chose /*Nisy niditra tsy nahazo alàlana tao antranonao ary nangalatra na nikasa hangalatra* B. Quelqu'un a délibérément détruit ou endommagé votre maison, boutique, ou tout autre bien vous appartenant ou appartenant à votre ménage /*Nisy nanimba ny tranonao, na tsenanao, na fanananao hafa* C. Quelqu'un vous a volé à l'extérieur de chez vous/*Nisy nangaltra na nandroba ianao teny ivelan'ny tranonao* D. Vous avez été victime d'agression/*Nisy namono na nanao herisetra taminao* E. Vous avez été victime d'abus et/ou d'harcèlement sexuel/Efa *nisy nanao fanolanana na herisetra ara-nofo na tsindry sy fikasana miendrika toy izany ve ianao ?* F. Autre/*Hefa*	1,2,3 Nb de fois ↓ A|__||__| B|__||__| C|__||__| D|__||__| E|__||__| F|__||__| *Si F, préciser* _____ ___ _____
SECTION 6 – Impact Sur Revenu (ISR)			
ISR1	Quel est votre revenu mensuel moyen maintenant ? (Revenu comprend toutes les formes de revenus)/*Ohatrinona ny vola miditra aminao isam-bolana izao ?*	1: 0–50 000 MGA 2: 100 001– 50 000 MGA 3: 150 001–200 000 MGA 4: 200 001–250 000 MGA 5: 250 001+ MGA 6: NSP–PDR	|__|
ISR2	Depuis l'arrivée de la mine, est-ce que votre revenu a augmenté ou baissé ?/*Hatramin'ny nisian'ny fitrandrahana dia nitom izany sa nihena ?*	1: Mon revenu a augmenté/ *Nitombo* 2: Mon revenu est le même/ *Tsy niova* 3: Mon revenu a baissé/ *Nihena* 4: NSP-PDR	|__|
ISR4	Depuis l'arrivée de la mine, est-ce que votre niveau de vie a augmenté ou baissé?/*Ny farim-piain anao ve nitombo s a nihena hay nisian'ny fitrandrahana ?*	1: Mon niveau de vie a augmenté/*Nitombo* 2: Mon niveau de v e est le même/*Tsy niova* 3: Mon niveau de vie a baissé/*Nihena* 4: NSP-PDR	__|
ISR5	Est-ce que ce changement est lié à l'arrivée de la mine ?/*Ny fisian'ny fitrand rahana ve no nahatonga izany ?*	1: Oui (*Eny)* on (*Tsia)* 3: NSP-PDR	|__|

SECTION 7 – Impacts Sur les Av irs (ISA) – Au sein du ménage			
SA3	Est-ce que votre terrain a été réquisitionné pour permettre l'exploitation minière à grande échelle?*Ny taninao ve isan'ny voakasika sy nala in' ny toeram-pitrand rahana ?*	1: Oui (*Eny)* 2: (*Tsia)* 3: NSP-PDR	|__|
ISA4	Quelle était la superficie du terrain? *Firy ny velaran'izany ?*	Indiquer le nombre en m²*soraty m²*	
ISA5	Combien avez-vous été dédommagé au total ?*Ohatrinona ny to ntalin'ny tambiny na onitra ?*	Indiquer le montant en Ariary *soraty ny sa ndany Ariary*	
ISA6	En quelle année?*tamin'ny taona firy izany ?*	Indiquer l'année/*soraty ny taona*	
ISA7	Avant 2005, dans quel type d'habitation viviez-vous ? *alohan'ny taona 2005, ohatr any ahoana ny trano nonenanareo ?*	Ecrire le code de s habitations */ soraty ny aodin"ny karazan'ny trano fonenana*	|__|
SECTION 8 – Accès aux Services de base (AS)			
Si l'en uêté possède un téléphone			
AS1	Avant 2005, aviez-vous accès à un réseau mobile où vous résidiez ou travailliez ? *Talohan'ny taona 2005, efa afampiasa reseau mobile ve ianao na tao antrano na tany ampiasana ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR	|__|
AS2	Maintenant, avez-vous accès au réseau mobile où vous résidez ou travaillez ? *Ary amin'izao, efa afaka nampiasa reseau mobile ve ianao na tao ant ano na tany ampiasan a ?*	1: Oui (*Eny)* 2: Non *)* 3: NSP-PDR	|__|
Pour tout enquêté			
AS3	Avant 2005 aviez-vous accès à une route praticable en toute saison à moins de 2 km de votre maison?*Talohan'ny taona 2005 efa nisy làlana azo naleha mandavantaona ve latsaky ny ny fonenanao ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR	|__|
AS4	Maintenant, avez-vous accès à une route praticable en toute saison à moins de 2 km de votre maison?*/ Ary amin'izao efa nisy làlana azo naleha mandav nta ona ve latsaky ny 2 km ny fonenana o ?*	1: Oui 2: Non (*Tsia)* 3: NSP-PDR	|__| *Si 2,3 passer à AS6*
AS5	Savez-vous comment cette route a été financée?**Fantatrao ve hoe ahoana no nanamboarana io làlana io ?*	1: Par le gouvernement/*Nata n'n y fanjakana* 2: P ar des bailleurs internationancl la Banque mondiale) /*Nataon'ny mpamatsy vola iraisampirenena (toy ny Banky iraisampirenena* 3: Par la société minière de otr e région/*Nataon'ny orinasa fitrandrahana* 4: Par une/des OSC/*Ny fiharahamonim--pirenena* 5: Autre/*hafa* 6: NSP-PDR	|__||__||__| *Si 5 préciser* _____ _____
AS6	Avant 2005, est-ce qu'il y a avait un centre de santé public à 30 minutes de votre maison?*Talohan'ny taona 2005, —sy tobim-p ahasalamana ve akaiky ny trna 30 minitra*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR	|__|
AS7	Maintenant, est-ce qu'il y a un centre de santé public à 30 minutes de votre maison?*/ Ary amin'izao, misy tobim-pahasalamana ve akaiky ny t anonao ? làlana 30 min itra*	1: Oui (*Eny)* 2: Non (*Tsi a)* 3: NSP	|__| *Si 2,3 passer à AS9*
AS8	Savez-vous comment ce centre de santé a été financé?* *fanta trao ve hoe ahoana no namboarana tobim-pahasalamana io ?*	Indiquer le code financement */Soraty ny kaodin 'ny famatsiambola*	|__||__||__*5 préciser* _____ __

AS9	Avant 2005, est-ce qu'il y a avait une écol e primaire publique à 30 minutes de votre maison?*Talohan'ny ta na 2005, nisy sekoly ambaratonga voalohany ve akaiky ny tranonao initra*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR		|__|
AS10	Maintenant, est-ce qu'il y a une école primaire publique moins de 30 minutes de votre maison?*Ary amin'izao, misy sekoly ambaratonga voalohany ve aka ky ny tranonao ? làlan a 30 minitra*	1: Oui (*Eny)* 2: Non (*Tsia)* NSP-PDR		|__| *Si 2,3 passer à AS13*
AS11	Est-ce que cette école est fonctionnelle ? *Mbola miasa tsar a ve io sekoly io ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR		
AS1	Savez-vous comment c ette école primaire a été financée ?* *fantatraooe ahoana no namboarana io sekoly io ?*	Indiquer le code financement/ *oraty ny kaodin'ny famatsiambola*		|__|| __||__| *Si 5 préc iser* _____ ____
AS13	Avant 2005, aviez-vous accès à au moins un type de services bancaires où vous résidiez ou travailliez ?*Talohan'ny taona 2005, efa nampiasa karazana fitantanam-bola toy ny banky ve intrano na tany ampiasana ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR		|__|
AS14	Maintenant, Avez-vous accès à au moins un type de services b ncaires où vous résidez ou travaillez? *Ary amin'izao, mampiasa karazana fitantanam-bola toy ny banky ve ianao na tao ant rano na any ampia sana ?*	1: Oui (*E ny)* 2: N*sia)* 3: NSP-PDR		|__|
AS15	Avant 2005, qu'est-ce que votre ménage utilisait pour cuisiner? *Inona no fa ndrehitra ampiasainareo talohan'ny taona 2005 ?*	1: Bois ramasse/*Kitay tsimponina* 2: Bois acheté/*Kitay vidi ana*	3: Charbon/*A rina* 4: Gaz/*Gaz* 5: Electric*erin'aratra*	6: Pétrole/*Petrol* 7: Autre/*Hafa* 8: NSP-PDR	|__|
AS16	Maintenant, qu'est-ce que votre ménage utilise pour cuisiner? / *Inona no fandrehitra ampiasainar eo amin'izao ?*	Indiquer le cod e élément de combu stion/*Soraty ny kaodin'ny fandrehitra*			|__|
SECTION 9 – Santé, WASH et sécuri té alimentaSW) – Depuis 2005 et l'arrivée de la mine					
SW1	Maintenant, comment évaluez-vous votre état de santé ? /*Manahoana ny fahitanao toe-pahasalamanao na ny ankohonanao izao ?*	1: Très mauvais/*Tensy* 2: Mauvais/*ratsy* 3: Satisfaisant/*Azoazo*		4: Bon/*Tsara* 5: Très bon/*Tena Tsara* 6: NSP-PDR	|__|
SW2	Est-ce que depuis l'arrivée de la mine votre état de santé s'est amélioré ou empiré ?*Niha-tsara ve ny toe-pahasal man areo hatry ny nahatongavan'n y fitrandrahana io ?*	1: Amélioré/*Nihatsar a* 2: Resté le même/ *Tsy niova*		3: Empiré/ *Nihar* 4: NSP-PDR	|__|
SW3	Pouvez-vous expliquer pourquoi? /*azonao hazavaina ve hoe nahoana ?*	1: Moins souvent malade/*Tsy dia marary matetika* 2: Mieux nourri (e)/*Tsara saka o* 3 : Meilleur accès aux s oins de santé/*Afaka tsara man antona tsara toeram-pit saboana*		4: Souvent malade/*Marary matetika* 5: Maladies nouvelles se sont propagé s de puis 2005/*Misy aretina vaovao hatry ny taona 2005* 6: Malnutrition *sy ampy saka fo* 7: Autre/*Hafa*	|__|
SW4	Combien de membres du ménage de moins de 45 ans sont décédés des suites de maladie ou accident de puis 2005?*Firy ny olona latsaky ny 45 taona maty noho ny aretina na ratra hatry ny taona 2005 ?*	Indiquer le nnombre de décès *Isan'ny maty*			|__|

SW5	Quel genre de toilettes avez-vous actuellement dans votre maison?*Inona no fomba na karazan'ny trano fivoahan a ampiasainareo ?*	1: Cabinet avec siège anglais/*Gaboné mipetraka maoderna* 2: Toile te à la turque/ *Gaboné « turque »* 3: Toilevec plate-forme à béton lisse, porcelaine, fibre de verre/*Gaboné lavaka beton na fibre de vera na bakoly*	4: Latrines avec plate- orm e en bois, terre,/*Gaboné lavaka gorodona hazo na tany* 5: Trou ouvert/*Lavaka fotsiny* 6: Dans la natur e/*eny rehetra eny* 7: Autre/*Hafa* 8: NSP-PDR	|__| *Si 7 préciser* _____ _
SW6	Depuis l'arrivée de la mine est-c e que le type de toilettes que vous utilisez a changé?*Nisy fiovana ve ny fomba na trano fivoahana nampiasainareo nanomboka ny nisian'ny fitrandrahana?*	1: Oui (*Eny)* 2: N*sia)* 3: NSP-PDR		|__|
SW7	Quel type de toilettes avez-vous utilisé avant 2005 ? *Inona no fomba na karazan'ny trano fivoah ana ampiasainareo talohan'ny 2005?*	Indiquer le code toilettes/*Soraty ny kaody*		|__| *Si 7 préciser* __ _____ __
SW8	En quelle ann ée cela a changé? *Oviana no niova izany ?*	Indiquer l'année (Doit être entre2005 et 2019)/Soraty ny taona (tokony ho anelanelan'ny 2005 sy 2019)		
SW9	Pouvez-vous expliquer pourquoi? I*nona no anto*	1: Il y a eu un investissement public dans le système local d'assa nissement et de toilettes/*Nisy fanampiana sy fanajariana an'ny fanjakana ho an'ny fahadiovana sy trano fivoahana iombonana* 2: Il y a eu un investissement privé dans le système local d'as sainissement et de toilettes/ *Nisy fanampiana sy fanajariana an'ny olo-tsotra ho an'ny fahadiovana sy trano fivoahana* 3: A cause du manque de ressources pour maintenir les équipements/*Noho ny tsy fahampian'ny ho enti-manana hikoloana ny fitaovana* 4: A cause de la propagation de maladies/ *Noho ny fihanaky ny aretina* 5: Autre/*Hafa* 6: NSP-PDR		|__| *Si 5 préciser* _____ _____ __
SW 10	Avant 2005, comment aviez-vous accès à <u>l'eau potable</u> ? *Talohan'ny 2005, nanana rano fisotro madio ve ianareo ?*	1 : A la maison (JIRAMA)/ao antrano 2: Puit/*lava-drano mitokana* 3: Puit communautaire/*lavadrano nana* 4: Borne fontaine/*paompy any ivelany*	5: Cours d'eau, rivière, étang, source/*renirano, dobo, loharano* 6: Bouteilles d'eau/*rano amin'ny tavoahangy vidiana* 7: Pas d'accès 8: Autre/*Ha fa* 9: NSP-PDR	|__| *Si 8 préciser* _____ _
12	Maintenant, comment avez-vous accès eau potable maintenant?*Ahoana no fahazoanareo rano amn'izao fotoana iza ?*	Indiquer le code d'accès à l'eau/*soraty ny kaody*		|__| *Si 8 préciser* _____ _
SW 14	Comment qualifiez-vous le changement d'accès à l'eau potable?*Ahoana no hikilasianao ny fiovana mahakasika ny rano izay ?*	1: Amélioré/*Niha tsara* 2: Resté le même/*Tsy niova*	3: Empiré/*Niha ratsy* 4: NSP-PDR	|__|

SW 15	Pourriez-vous nous expliquer ce qui a causé ce changement?**Azonao hazavaina ve ny anton'izay fiovana izay ?*	1: Il y a eu un investissement public dans le système d'eau pot able/*Nisy famatsiana sy fanampianan'ny fanjakana ny sehatra rano fisotro h o an'ny daholobe* 2: Il y a eu un investissement privé dans le système d'eau potabl e/ *Nisy famatsiana sy fanampiana avy amin'ny tsy mia nkina ny sehatra rano fisotro* 3: La société minière a investi dans le système d'eau potable/*Ny orinasa fitrandrahana no nampiditra rano ho anay* 4: Mise en œuvre de droits d'eau garantissant l'accès/*Napetraka sy najaina zo hahazo rano*	6: A cause du manque de ressources pour maintenir les équipemen ts /*tsy ampy ny ho entimanana sy ny fampitaovana hikojana ny fitaovana* 7: A cause de la propagation de maladies/*No ho ny fihanaky ny aretina* 8: A cause de la pollution due aux activités minières à grande éch elle/*Noho ny fahalotoana sy fahasimbana nateraky ny fitrandrahana* 9: A cause d'une catastrophe naturelle/*Tranga sy loza voajanahary* 10 : Mise en œuvre des droits d'eau qui restreignent l'accès/*Noho ny fihe nana na fandrarana tsy hisitraka ny zo hahazo rano* 11: La source d'eau locale n'est plus accessible/*Tsy afaka ampiasaina intsony ny loharano eto antoerana* 12: Autre/*Hafa*	|__||__||__| *Si 11, préciser* _____ __
W 17	Est-ce que la qualité de l'eau douce changé depuis l'arrivée de la m ine?*Nisy fiovana ve ny kalitaon'ny rano hatry ny nahatongavan'ny itr andrahana ?*	1: Améliorée/*Nih a tsara* 2: Restée la même/*tsy niova*	3: Empir ée/*Niha ratsy* 4: NSP-PDR	|__|
SW 18	Pourriez-vous expliquer ce qui a causé ce changement?**Azona hazavaina ve ny antony nahatonga iz any fiovana izany ?*	1: Amélioration des pratiques agricoles/*Fanatsaràna ny fom ba fambolena* 2: Améliora tion des pratiques de gestion des déchets/*Fanatsaran a ny fitant ny fako* 3: Amélioration de la gestion des produits chimiques dang ereux/*fanatsarana ny fitantànana ireo vokatra simika sy mamp did oza*	4: Pollution provenant des activités d'exploitation minière à gran de échelle/*fandotoana vokatry ny orinasa fitrandrahana* 5: Pollution due à la mauvaise g estion des déchets/*Fandotoana vokatry ny tsy fahaiza-mifehy ny fako* 6: A cause de la propagation de maladies/*noho ny fihanaky ny aretina* 7: Autre/*hafa*	|__| *Si 7, préciser* _____ _
SW 19	Combien de fois mangez-vous de la viande ou du poiss on par semaine? *Im-piry isan-kerinandro ianareo izao no mihinana hena na trondro ?*	Indiquer le nombre de fois/*soraty ny isa*		|__|
SW 20	Avant 2005, combien de fois mangiez-vous de la v ou du poisson par semaine ? *Ary talohan'ny taona 2005,* *im-piry isan-kerinandro ianareo no mihinana hena na trondro ?*	Indiquer le nombre de fois/ *soraty ny isariorit*		
SW 21	Maintenant, combien de repas par jour faites-/*im-piry isanandro ianareo no misakafo izao ?*	Indiquer le nombre de repas/*soraty ny isan' y sakafo*		|__|
SW 21 bis	Avant 2005, combien de repas par jour faisiez-vo192rioritp*iry isanandro ianareo no misakafo talohan'ny taona 2*	Indiquer le nombre de repas *soraty ny isan'ny sakafo*		|__|
SW 22	Maintenant, est-ce qu'il vous arrive e sauter des repas ? *Misy fotoana ve izao tsy misakafo eo ?*	1: Très souvent (par semaine) *Matetika (isan-kerinandro)* 2: Souvent (par mois) *Tsindraindray (isam-bolana)* 3: Parfo s (par trimestre)/*Indraindray (isan-telovolana)*	4: Rare(par an) *Tsy dia matetika (isan-taona)* 5: Jamais/*Tsia* 6: NSP-PD	|__|

SW 23	Avant 2005, est-ce qu'il vous arrivait de sauter des repas ?/ *Ary talohan'ny taona 2005, misy fotoana ve izao tsy misakafo ianareo ?*	Indiquer le code de fréquence des repas/*Soraty ny kaody*		|__|
SW 24	Comment expliquer ce qui a causé ces changements en termes de votre accès à la iture, la quantité et la qualité alimentaire disponible ? */Ahoana o hanazavanao izany fiovaovana ara-tsakafo izany ? ny kalitao sy ny habetsany ?*	1: Amélioration de la productivité agricole/ *Niha ny vokatry ny fambolena* 2: Meilleur niveau de vie/*Nihatsara ny farim-piainana* 3: Plus facile d'accéder aux marchés/Noho ny fisokatry ny tsena 4: Diversité accrue des aliments disponibles/ *Fitobahan'ny kar zan-tsakafo* 5: Investisseme t du gouvernement local dans la sécurité alimentaire/*Famatsian'ny fanjakana ara-tsak afo* 6: Investissement de la société minière dans la sé curité alimentaire/*Fanampian'ny orinasa ftrandrahana ny resaka sa kafo* 7: Investissement des sociétés civiles locales dans la sécurité alimen taire/ *Famatsianan'ny fiarahamonim-pienena ara-tsakafo*	8: Diminution de la production agricole/*Fihenan'n y vokatra ara-pambolena* 9: Aggravation des conditions de vie/*Niharatsy ny farim-painana* 10: Plus difficile d'accéder au x marchés/*Fahasarotana ny tsena sy lalam-barotra* 11: Moins de diversité d'aliments disponibles/*fahavitsian'ny karazana sakafo misy* 12: Quantités moindres d'aliments disponibles/*Tsy fahampian'ny kali tao ara-sakafo* 13: Augmentation des prix des denrées alimentaire s/*fiakaraan'ny vidin'ny sakafo* 14: Autre/*Hafa*	|__| *Si 14, préciser* _____ __ __
SW 25	Comment vous éclairez-vous à votre domicile?/*inona no ampiasainareo ho fanazavana ny trano izao ?*	1: Electricité/*Herin'aratra* 2: Générateur/ *gropy* 3: La mpe à pétrole ou à l'huile/*jiro solika na jabora*	4: Bougies/*labozia* 5: Autre/*ha fa*	|__| *Si 5, ser* _____ _
SW 26	Comment vous éclairiez-vous à votre domicile avant 2005? */inona no ampiasainareo ho fanazavana ny tranotaloha 'ny taona 2005*	Indiquer code én ergie/*Soraty ny kaody*		|__|
SW 27	Pourriez-vous nous expliquer ce qui a cau sé ce changement ? / *Inona no anton fiovana izay ?*	1: investissement public dans le système d'alimentation électrique /*Famatsian'n y fanjakana ny herin'aratra* 2: investissement privé dans le système d'alimentation électrique/*famatsian'ny tsnkina herin'aratra* 3: investissement de la société minière dans le système d'alimentation électrique/*F mats ian'ny orinasa fitrandraha aherin'aratra*	4: manque de ressources pour maintenir les équipements/*Tsy fahampi an'ny ho enti-manana* 5: catastrophe naturelle/*Loza voajanahary* 6: Autre/*hafa*	|__| *Si 6, préciser* _____ _____ __
SW 28	Maintenant, comment dépensez-vous l'argent par mois?/*inona no fandaniana ara-bola ataonareo isam-bolana amin'iz ao fotoana izao?*	A: Alimentation/*Sakafo* B: Loyer/*Hofantrano* C: Education/*Fampianarana* D: Loisirs/*Fialamboly*	E: Transport/*Fitat erana* F: Santé*salamana* G: Cadeaux/*fanomezana* H: Autre/*hafa*	BOULIER
SW 29	Est-ce que vos dépenses ont changé depuis 2005 et le l'arrivée de la mine?/ *Niova ve izany fandaniana izan y n oho ny fisian'ny fitrand rahana hatry ny taona 2005*	1: Elles ont augment é/ *Nitombo* 2: Elles so nt restées au même niveau /*Tsy niova*	3: Elles on t baissé/*Nihena* 4: NSP -PDR	|__|
SW 30	Avant 2005, comment dépensiez-vous l'argent par mois?/*Inona avy ireo fiovana amin'ny fandanina arabola?*			BOULIER

SW 31	Pourriez-vous nous expliquer ce qui a causé ce(s) ch angement(s)?*/*Inona no mety naha tonga izany fiovana izany ?*	1: Les produits de base sont devenus moins cher s/*Niha lafo ny vidin-javatra* 2: Les produits de base sont devenus plus c hers/*Niha lafo ny vidin-javatra* 3: Changements da ns la composition du ménage/*Niova ny isan'ny olona tanaty tokatrano* 4: Plus de c hoix et de quantité disponible / *nitombo ny sa idy sy ny karazan-javatra misy*	5: Moins de choix et de quantité disponible / *nihena ny safidy sy ny karazan-javatra misy* 6: Population locale plus nombreuse du fait de la migration /*Niha maro ny mponina noho ny fisian'ny vahiny* 7: Autre/ *hafa*	|__| *Si 7, préciser* _____ _
Vous avez terminé l'enquête. Merci beaucoup pour vot re temps.				
Q1	*Sao mbola misy tianao lazaina na hanampiana izay voalaza ?*			
Q2	*Amin'ny t apatapaky ny volana Mey 2020 no ho vita ny famintinana ny fanadihadiana ary hisy dika mitovy ho apetraka eny amin'ny Kaominiila izany ve ianao ?*	1: Oui (*Eny)* 2: Non (*Tsia)* 3: NSP-PDR		|__|

Appendix 5.5: Interview questionnaires

Number	Questions
1	Can you tell me more about your job and work background in this sector? (Prompt: duration, locations, responsibility/scope)
2	What is your overall perspective of the industrial mining industry in Madagascar and in the sub-Saharan region?
3	We are now going to focus on the benefits of industrial mining. Since the start of the construction of the QMM mine in 2005, do you think the industrial mining industry has been beneficial to the country? If so can you explain how, why and when (try to use existing statistics and data whenever possible)
4	Do you think these benefits also apply to regions and local communities with mining activities? Or do the latter receive different kinds of benefits? Can you explain how, why and when (try to use existing statistics and data whenever possible)
5	In your opinion, what would increase the benefits of industrial mining? (Prompt: at national, regional and local levels)
6	Now that we've talked about the benefits, I would like to talk about the negative impacts of industrial mining. Since 2005, has industrial mining had negative impacts in Madagascar? If so can you explain how, why and when (try to use existing statistics and data whenever possible). Prompt: focus on economic and social impacts rather than environmental.
7	Do you think these negative impacts also apply to regions and local communities with mining activities? Or do the latter receive different kinds of benefits? Can you explain how, why and when (try to use existing statistics and data whenever possible)
8	In your opinion, what would mitigate the negative impacts of industrial mining? (Prompt: at national, regional and local levels)
9	Before we finish this interview, is there anything else you would like to add?
10	Would you like to receive a copy of the summary of the findings?

Appendix 5.6: Survey administration process

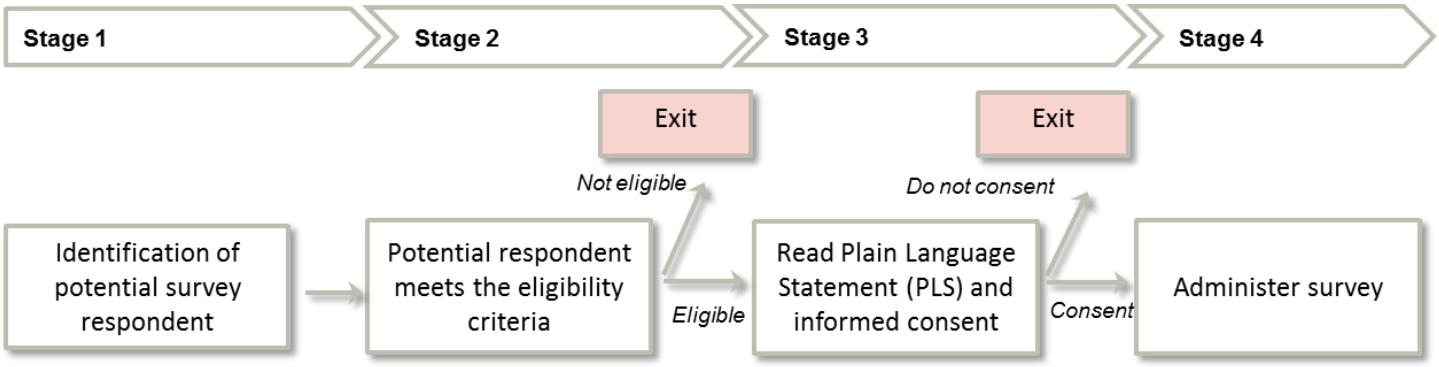


Figure 29: Survey administration process

On average, each survey took 38 minutes. After being given, each survey was verified until validation as described in Figure 30.

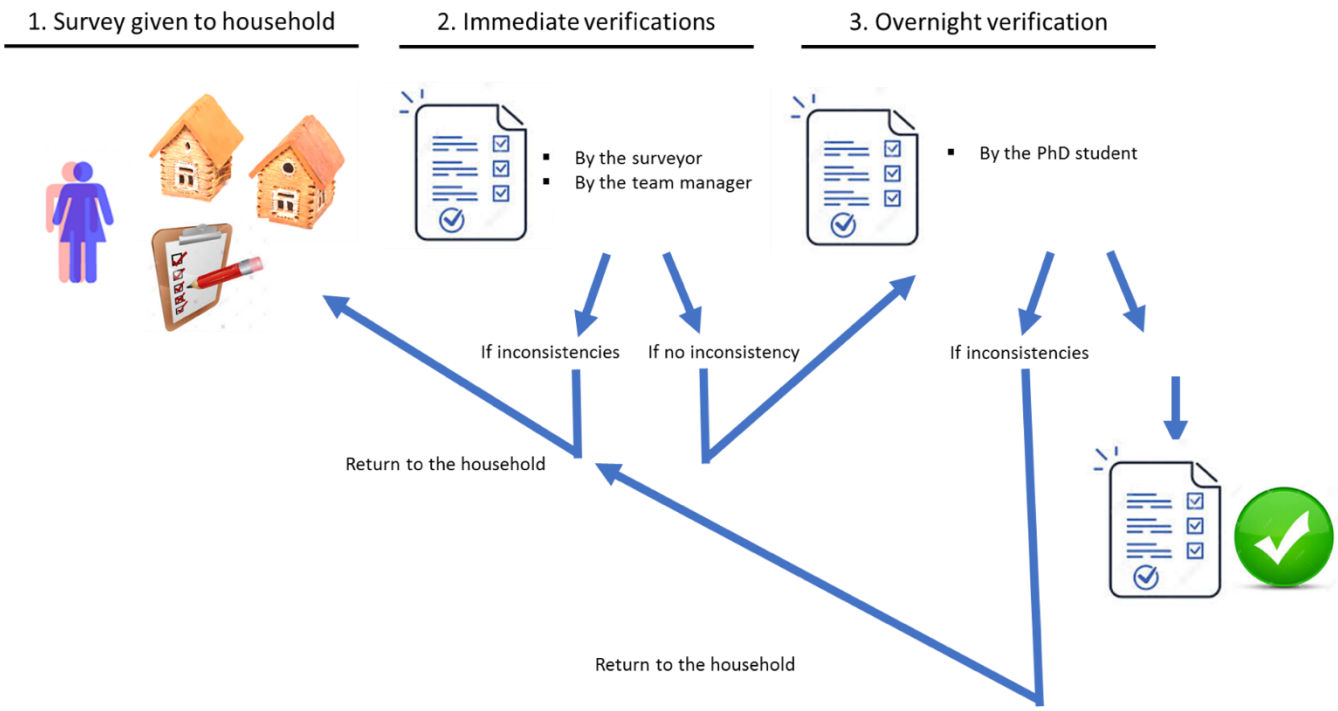


Figure 30: Verification process of each survey during the data collection

The data was captured on paper and entered progressively by the PhD student and five research assistants on KoBoToolbox, which is a secure survey tool that works online and offline.

Appendix 5.7: Multidimensional Poverty Index

Dimensions of Poverty	Indicator	Deprived If...	Weight
Education	Years of Schooling	No household member aged ten years or older has completed six years of schooling.	1/6
	Child School Attendance	Any school-aged child+ is not attending school up to the age at which he/she would complete class 8.	1/6
Health	Child Mortality	Any child has died in the family in the five-year period preceding the survey.	1/6
	Nutrition	Any adult under 70 years of age or any child for whom there is nutritional information is undernourished.*	1/6
Living Standard	Electricity	The household has no electricity.	1/18
	Improved Sanitation	The household's sanitation facility is not im-proved (according to SDG guidelines) or it is improved but shared with other households.**	1/18
	Improved Drinking Water	The household does not have access to im-proved drinking water (according to SDG guidelines) or safe drinking water is at least a 30-minute walk from home, roundtrip.***	1/18
	Housing	The household has inadequate housing: the floor is of natural materials or the roof or wall are of rudimentary materials.	1/18
	Cooking Fuel	The household cooks with dung, wood, or charcoal.	1/18
	Assets Ownership	The household does not own more than one of these assets: radio, TV, telephone, computer, animal cart, bicycle, motorbike, or refrigerator, and does not own a car or truck.	1/18

Source: Alkire et al., 2018.

Table 37: MPI per indicator for sample collected

Main results N = 730

	Coef.	Std. Err.	[95% Conf.	Interval]
Main				
H	0.501	0.019	0.465	0.538
M0	0.254	0.010	0.234	0.274
Additional				
A	0.506	0.008	0.490	0.523

Note: Adjusted Multidimensional Headcount M0 = H*A

H: The multidimensional deprivation headcount (the share of poor individuals in the population).

M0: The adjusted headcount ratio, M0 = H*A, which accounts for both the incidence of poor individuals and the intensity of their multiple deprivations.

A: The average multidimensional poverty intensity or average percentage of simultaneous deprivations suffered by the poor individuals.

Appendix 5.8: RMIT Ethics approval number 21888

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Notice of Approval

Date:	21 December 2018
Project Number:	21888
Project Title:	*Industrial mining in Madagascar: an interdisciplinary approach to assess the economic and social impacts at macro, meso and micro-levels*
Risk Classification:	Low Risk
Chief Investigator:	Professor Simon Feeny
Other Investigators:	Dr Sefa Awaworyi Churchill, Ms Mireille Razafindrakoto (DIAL) Prof Herinjatovo Aimé Ramiarison (University of Antananarivo)
Student Investigator:	Mrs Agathe Tiana Randrianarisoa
Project Approved:	**From: 21 December 2018** **To: 1 January 2022**

Terms of Approval:

Responsibilities of the Principal Investigator
It is the responsibility of the principal investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by BCHEAN. Approval is only valid while the investigator holds a position at RMIT University.

1. *Amendments*
   Approval must be sought from BCHEAN to amend any aspect of a project including approved documents. To apply for an amendment submit a request for amendment form to the BCHEAN secretary. This form is available on the Human Research Ethics Committee (HREC) website. Amendments must not be implemented without first gaining approval from BCHEAN.
2. *Adverse Events*
   You should notify BCHEAN immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
3. *Participant Information and Consent Form (PICF)*
   The PICF must be distributed to all research participants, where relevant, and the consent form is to be retained and stored by the investigator. The PICF must contain the RMIT University logo and a complaints clause including the above project number.
4. *Annual Reports*
   Continued approval of this project is dependent on the submission of an annual report.
5. *Final Report*
   A final report must be provided at the conclusion of the project. BCHEAN must be notified if the project is discontinued before the expected date of completion.
6. *Monitoring*
   Projects may be subject to an audit or any other form of monitoring by BCHEAN at any time.
7. *Retention and Storage of Data*
   The investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Chapter 6: Conclusion and policy recommendations

"Additional mining investments won't change things on their own. There will be no miracle if the authorities at national, regional and local levels do not foster a favourable legal, economic and social environment." (CSO employee)

6.1 Introduction

Whether LMI countries are going to be able to execute efficient strategies to finance their own sustainable development is going to determine if they manage to lift their populations out of poverty and reach the SDGs goals by 2030. LSM has been identified as a development catalyst if its benefits are maximised and its negative impacts mitigated (Columbia Center on Sustainable Investment 2016, 2020). Yet, it requires objective and detailed evidence to inform the development of efficient policies.

This thesis focuses on the case study of Madagascar since its mining industry is relatively recent and therefore "before mining" and "after mining" can be measured, mining permits are under review yet the literature of the economic and social impacts of LSM in this country is quite scarce, and most importantly it is one of the poorest countries in the world. Indeed, the country has a 2019 HDI ranking of 162 out of 189 (UNDP 2019), 73.3% of the population live with less than USD1.90 per day (World Bank 2020) and nearly one child in two under the age of five suffers from stunting (UNDP 2019). Thus, the stakes are very high for the Malagasies for the contribution of these large mines and finite resources to be enhanced.

Most of the studies on the impacts of LSM in Madagascar focus on environmental impacts. Those which examine the economic and social impacts focus on one mine, use small samples of primary data or use secondary data for forecasts, not comprehensive

assessments of past performances. Therefore, this study aimed to address these gaps by combining large secondary dataset with primary quantitative and qualitative information across disciplines, and conduct an analysis at national, regional and local levels. In order to provide evidence of the impacts of LSM and inform future decision-making of mining stakeholders, this thesis attempts to investigate three research questions:

1. What have been the economic and social impacts of industrial mining at the country level in Madagascar in comparison to other sub-Saharan mining countries?
2. What have been the economic and social impacts of industrial mining in mining regions in comparison to non-mining regions in Madagascar?
3. What have been the economic and social impacts of industrial mining on households and individuals in mining communities in comparison to non-mining communities?

The rest of this chapter is structured as follows. Section 6.2 provides a summary of findings from the thesis. Section 6.3 presents policy recommendations including some for mining stakeholders that are augmented with insights from the 83 semi-structured interviews. Finally, Section 6.4 discusses the limitations of the study and suggests areas for further research.

6.2 Summary of findings

The systematic literature review presented in Chapter 2 examines 107 studies according to a set of selection criteria including strict focus on impacts of LSM in LMI countries, hard minerals and having an empirical approach. This review shows that LSM generates revenue for LMI countries' governments in various forms but that they are highly volatile and often difficult to fully collect. In terms of impacts on domestic spending, LSM does foster domestic spending through investments and employment (direct, indirect and induced) even though it needs scaling-up to benefit more people. As for whether mining has been as an engine of growth for African mining countries, this is contested. In this systematic review of literature, 13 studies found that mining boosted economic growth and 25 that it hasn't. Last but not least, LSM does not appear to have been a catalyst for development from the literature reviewed, and there is a strong consensus on the detrimental social impacts of LSM. Out of the 107 studies selected, only 12 outline the social benefits of mining. Most importantly, the review highlights the conditions that mediate the impacts of LSM such as the need to strengthen governance, foster linkages and adopt safeguards to the type of mineral mined. Finally, this systematic literature review enables us to conclude that to accurately assess the impacts of LSM, country, regional and local-level econometric approaches need to be augmented with the collection of primary quantitative and qualitative data using an interdisciplinary approach. This research design is applied in chapters 3, 4 and 5.

The analysis of economic and social impacts of mining showed that Madagascar differs from its sub-Saharan African mining neighbour countries and lags behind, especially in terms of GDP per capita, mining rents and HDI. As for the econometric analysis, economically the results are not conclusive, which may be due to the relative recency of the mining industry in Madagascar compared to other sub-Saharan African mining

countries. Socially, LSM is negatively associated with the HDI. Even though causality can't be established our findings outline that LSM has not led yet to the visible positive social improvements expected at the national level. Yet, the qualitative analysis seems to reveal more positive outcomes that are not captured as it is difficult to infer a relationship at this level.

In order to refine these findings, Chapter 4 investigates the impacts of LSM at regional level. They appear to be heterogenous and a mixed blessing depending on where individuals live and the type of outcomes; that is, living standards (wealth index), housing characteristics, WASH and asset ownership. Our findings show that there seems to be a threshold for individuals to benefit from mining. Those who are close to the mine, within 0 to 20 km, have benefited more from it compared to those who live further away, for whom most outcomes have dropped since the mine arrivals. This is mainly due to the access to employment opportunities (direct, indirect through procurement or induced by spending) and new infrastructure built (e.g., roads, ports, WASH). More specifically, up to 60 km, impacts are overall negative. However, beyond this threshold of 70 km, which roughly corresponds to the size of districts in Madagascar,[20] impacts appear to be more positive, with neighbouring districts reporting better outcomes than mining districts, especially in terms of living conditions and asset accumulation. This positive outcome for neighbouring mining districts results from less disruption of economic and agricultural activities, as well as access to some of the large infrastructures built such as ports and roads; whilst mining districts have experienced a sharp rise in inflation due to the mining boom and a pull effect on the most deprived migrants. With limited assets owned and education, these migrants tend to struggle to fend for themselves and lower the overall wealth index of mining districts. Although these findings contribute to the understanding

[20] Author's calculations based on the average size of the 114 districts in Madagascar.

of the differentiated impacts between national and regional levels, they are unable to distinguish how households and individuals within these radii have been impacted by the large-scale mines. This is particularly important in a country with limited roads and transportation infrastructure (Razafindrakoto, Roubaud & Wachsberger 2020). Furthermore, a large proportion of the population are dependent on subsistence farming to survive and therefore any disruption to their livelihoods with potential land acquisition or pollution for example could have acute effects on their economic and social situation.

Thus, Chapter 5 focuses on the local impacts of LSM for communities living near Ambatovy and QMM. It provides evidence that as expected given the pre-existing socio-economic conditions, the number of people directly affected and the size of the investment made, communities near Ambatovy have experienced better outcomes than those near QMM in terms of income increase, lower chances of deprivation, improvement of livelihoods, health level, and food security. Yet, those near QMM tend to report higher income levels since the arrival of the mine in 2005. Despite more tensions and assaults in this southeastern area of Madagascar, households report higher level of trust in their local authorities than near Ambatovy. As expected, working in mining – either directly or indirectly – leads to much better outcomes, especially economic ones. Yet, it doesn't seem to create social divisions unlike in other countries, which is extremely positive compared to peer sub-Saharan countries where resources have been at the core of civil conflicts. This would need to be closely monitored over time, especially as the rise in inequalities may lead workers to feel more unsafe and to separate themselves more from their community. Finally, and most surprisingly, those who are the closest to the mines are not those who benefit the most partly because of the impact on land, access to resources, pollution and the overall scale of disruption. Those who seem to fare better are those in the 11 to 15 km radius, providing they have access to a main road. Thus, our

analysis shows that for LSM to foster sustainable local development, several conditions need to be met. To start with, the size of the investment by the mining company must be large enough that it will hire more local people and create more indirect work through procurement contracts. Then, the number of people disrupted by the mine arrival needs to be as small as possible. In areas with limited economic opportunities and low education level, transitional programs will not be sufficient to enable those who have lost their main revenue source (e.g., fishing or agriculture).

These findings can now be used to inform decision-making and policies of mining stakeholders. The next section provides policy recommendations to mitigate and/or enhance the impacts of LSM in Madagascar. These suggestions are augmented with insights from the 83 interviews.

6.3 Policy recommendations to mitigate or enhance the impacts of LSM in Madagascar

6.3.1 Increase the transparency and accessibility of mining-related information at all levels (mining companies, authorities, CSOs/NGOs)

Even though Madagascar is implementing the Extractives Industry Transparency Initiative (EITI) Standard (after a suspension between 2011 and 2014 due to the political crisis), 19 interviewees out of 83 outlined the lack of transparency and accessibility of information related to mining companies' activities. According to the interviewees, this is fuelling corruption and frustration in local communities. It also prevents CSOs and NGOs to develop adequate programs and advocacy campaigns addressing actual needs. According to these interviewees, what is at stake with the transparency and accessibility of information to start with is to be able to know how mining permits are granted and to ensure that each step has been implemented and that any legislative change follows a

democratic process. A mining expert reported that changes had just been made on the granting of mining permits by ordinance, circumventing the vote of the National Assembly. It is also about how the mining revenues are spent, once allocated to national, regional and local authorities. This would reduce the *"widespread corruption",* said a government official at local level. As such, the lack of transparency of local and regional authorities, as well as villagers' associations supported by the mining companies, was identified by various participants. The regular reporting required is often not done. *"They are not accountable for their management of the revenues"* highlighted a local citizen who used to work for QMM. A mayor near Ambatovy told us that the only way to obtain information about the mine is to work there or know someone close who does.

Some interviewees also noted that the "cahiers des charges" – called construction specifications in this context – are not public and no one is able to assess the discrepancies between what was initially agreed upon with authorities and what has been realised, with potentially poor consequences on local communities and their environment. Interviews conducted with people working in CSOs and NGOs indicated that they deplored the lack of credible and reliable data, preventing them to efficiently protect the interests of the Malagasies. For example, there is no transparent complaint mechanism. If a member of the community reports a complaint about the lack of access to natural resources, employment or about a land dispute to a mining company, local authorities and local CSOs/NGOs can have a hard time accessing them and cannot support the claimant. The Catholic Relief Services (CRS) used to run the Taratra program near the Ambatovy mine but has removed the complaint mailboxes at Protestant churches, which were part of the network in 2018. Since then, there has been no coordinated way to collect complaints and follow them through, according to an NGO employee. The same thing applies to the complaints lodged with the Office National de l'Environnement (ONE) by

citizens. The latter are not necessarily made aware of whether a complaint has been addressed by the mining company, even when it deals with evidenced pollution claims. Finally, and probably most importantly, most interviewees highlighted the difficulty for a large portion of Malagasies to have access and understand the way information about mines are presented. Efforts were noted to improve communication with local communities, especially through QMM's open-door event to celebrate its 10-year anniversary or the work done by the "équipes sociales" (community relationship teams). Yet, mining employees themselves acknowledged that "*it is difficult for local people here to understand what a large-scale mine is*". A community relationship manager added that at the scale of most Malagasies who live under the poverty rate, comprehending that an investment of USD930 million is not leading to their own improvement in livelihoods is hard. Nevertheless, increasing the transparency and accessibility of mining-related information would also *"reduce the rumors, the frustrations and conflicts, as well as the politisation of the debate on Large-Scale Mining",* concluded a representative of an NGO.

Making information transparent and accessible would be the first step in enabling the monitoring and evaluation of the impacts of LSM in an independent manner.

6.3.2 Guarantee the independence of impact monitoring and evaluation of the impacts

As demonstrated by this thesis, independent assessments are essential to evaluate the impacts of LSM to properly inform government policies and mining company processes. They enable necessary improvements and changes before the damages are too great. Twelve interviewees stressed the need for impact monitoring and regular evaluations to take place that would be conducted independently from mining companies.

According to these interviewees, the bias in favour of mining companies was introduced at the very start of the mining cycle. The country mapping of minerals was done by QMM, explained an employee, and made public by the company as a contribution to the country. But the state has never been able to conduct audits or updates, lacking the necessary knowledge and resources. Similarly, the environmental assessment and feasibility studies were conducted by international consultants but commissioned and paid for by the mining companies. Since 2004 a panel of experts was formed to assess the impacts of QMM. Yet, after international donors stopped funding the panel in 2011, QMM started funding the panel from 2017. Interviewees also revealed the lack of independence of ONE, which is mostly funded by mining companies.

Independent monitoring and evaluation of impacts would enable any party to track down spending by authorities and CSOs/NGOs. It would also demonstrate how protected areas are affected. An environmental specialist called them *"protected areas on paper".* Further, it would provide evidence to make sure the existing mining legislation is enforced, provide sanctions when required and amend the legislation when needed, stated a mining expert. Several participants mentioned the example of one of the four commune beneficiaries of the revenues from QMM since 2008, where not much has been done for the local communities.

6.3.3 Revise the mining code

The revision of the mining code has been on the cards for years, as discussed in Chapter 3 on national impacts. This echoes the overwhelming conviction of 31 of the interviewees that the mining code must be revised to enhance benefits and mitigate negative impacts. To start with, participants supported the increase in royalties from 2% of the value of mining products to at least 5%. According to an academic and mining expert, Madagascar

negotiated *“a very poor deal”.* A mining expert explained that this low rate was set to entice investors to invest in Madagascar despite the lack of infrastructure. Yet, this person also added that for a company like Ambatovy that also transforms its production in the country, the rate is halved and therefore this mining company pays 1% on the sale of its products. A series of tax exemptions have been granted to QMM and Ambatovy as part of the special fiscal regimes they benefit from (the Convention of Establishment and the Large Mining Investment Act). For example, QMM doesn’t pay the national GST (called Taxe sur la Valeur Ajoutée in Madagascar), which is in the general mining framework set at 20% of sales (Moore Stephens 2015). For some of these participants, any future revision of the mining code should remove these exemptions. In addition, a few interviewees asserted that mining companies should pay taxes on the amount of natural resources they have used to extract the minerals. For example, water used by the mines is not taxed, and for local authorities, CSOs and mining experts alike this is not a fair deal for the Malagasies.

A couple of mining experts also noted that until recently, there was no legal requirement to prevent proceeds repatriations from the sale of mining commodities to countries overseas and that it needs to be properly monitored to stop the devaluation of the Malagasy Ariary currency. Further, some interviewees suggested updating the legal text as reference values used for the calculation of the taxes date back from 2001 and can be up to 2.2 times smaller due to changes in commodity prices. Finally, interviewees mentioned the initial attempt to create a sovereign fund similar to the ones Norway and Saudi Arabia have created. They said that the short-termism of authorities at all levels and the appeal of immediate gain prevailed over a longer-term strategy which would guarantee that future generations of Malagasies benefit from these proceeds. According

to them, this mining sovereign fund should be created. In the meantime, interviewees suggested several ways for communities to directly benefit from LSM activities.

6.3.4 Increase direct benefits for communities now and in the future

The payment of mining taxes and royalties through the central administration that transfers 10% to an equalisation fund, then distribute it to regions (30%) and communes (60%), does not seem to benefit local communities much, as discussed above. *"We've seen a lot of (commune) mayors become considerably richer since QMM arrived in the area",* said a QMM employee. *"These mining revenues never reach the fokontanys"* asserted a deputy mayor near Ambatovy. While some municipalities are actively trying to increase the amount of benefits using these revenues such as in Ampasy Noapaena – where a unique scheme enables those who pay their taxes to access health cover – increasing direct benefits to communities in a sustainable way and that would not be dependent of the good governance of local authorities is crucial, as outlined by several interviewees.

More specifically, to increase the direct benefits to communities now and in the future three strategies were suggested by 19 interviewees: (1) more local jobs and procurement contracts; (2) more training opportunities; and (3) a direct payment to Malagasy citizens. Direct employment by mining companies remains low relative to the size of their investment as explained in the three empirical chapters of this thesis. Consequently, it is one of the main complaints that mining companies receive and a source of great disappointment according to mining employees and local authorities. The main argument given by mining companies is that the skills needed are not available locally. *"I would give the preference to a local recruit if the person had comparable skills to someone from somewhere else … But it is hardly the case"* pointed out a mining employee. Interviewees

agreed that this need for specific skills should have been addressed well before the start of the construction of the mines, when thousands of foreign workers were flown in to build the mines. *“The state would have had ample time to support people developing the adequate skills if it had prioritised it”* asserted a representative of a CSO. Nevertheless, participants highlighted that a lot could still be done to create more opportunities for local communities, especially for the youth in areas where their unemployment is deemed as high. *“Those who just passed their baccalaureate can’t find a job, they’re just disgruntled”,* said a mining employee in charge of social programs. More vocational training available to local communities for the whole duration of the mining permit would help for example said a Head of District and a representative of a CSO. In terms of indirect jobs, those created by the social funds or through procurement, interviewees also noted room for improvement in terms of scaling up their impact.

According to the participants, the main barriers to local procurement are the lack of businesses formally registered, their low cashflows preventing them to offer attractive payment deals or even to survive in case of delayed payment, small production, and their relatively lower quality standards. For example, the meat served to the employees at Ambatovy’s canteen comes from the capital and not from local farmers, despite their abundance. Interviewees perceived these issues as circumventable providing different levels of government, mining companies and the civil society work together to support local producers and service providers. If the current multiplier of a job at a mining company supports six people (according to a QMM employee), boosting direct and indirect employment as well as providing vocational training would certainly increase the number of beneficiaries, while also empowering them.

Finally, a few interviewees as well as a renowned local economist suggested the implementation of a universal basic income for all Malagasy citizens funded by mining

revenues which would guarantee a direct benefit of the LSM industry regardless of governance. This “resources-to-cash transfers” have been tried in Mongolia for example from 2010 to 2012 (Yeung and Howes 2015) and its experience could be used to design and implement an adequate scheme for the Malagasies. This would enable the groups that are the most negatively impacted to benefit equally from mining activities such as youth, women, and those in agriculture, fishing, craftsmanship and forestry, according to interview participants and survey respondents.

Most interviewees made suggestions for the three main types of mining stakeholders: governments at national, regional and local levels; CSOs and NGOs; and finally mining companies.

6.3.5 Recommendations to mining stakeholders

Governments: more coordinated and efficient interventions are required

Nineteen interviewees had the overall conviction that governments at national, regional and local levels would need to work collaboratively and more efficiently to maximise the benefits of LSM and mitigate its negative consequences.

More specifically, participants highlighted the lack of pre-emption in terms of skills and business type needed when the mining permits were granted. This anticipation would have considerably helped Malagasies be hired by the mining companies or provide them with more opportunities for procurement. A program coordinator at a CSO outlined that *“the lack of support from the state prevented peasants the benefiting at all from the mining industry. Yet, if needs had been identified some of them could have upskill into mechanics for example, which would have been very helpful to the mining companies”.* This was stressed by several interviewees including mining experts, mining employees and representative of NGOs. Further, these interviewees deplored the lack of strategy for the

industry, which according to the head of a global NGO meant that *"without a strategy, there are no proper linkages with other industries and Ministries, preventing an efficient response to tackle Madagascar's development issues"*. A few interviewees working for regional or local authorities asserted that the lack of implementation in decentralisation has also been an obstacle to getting the mining revenues and spending them according to the needs of their population. A mayor said, *"Moramanga (the capital city near Ambatovy) has its own local tresory (TEPIC) but we still don't, and we don't know why. We've been told that it's about to be open for years. This slows down anything we need to do."*

At regional and local levels, what seems to be missing the most is the capacity to assess deals and to deal with large budgets. Eight interviewees highlighted the urgent need for capacity building in budget management and planning. *"How to all of a sudden deal with the allocation of budgets that have considerably increased when you used to function with almost nothing?"* pinpointed a mining expert and academic. For these interviewees, there has been a lack of training which has led to numerous mismanagement issues and fostered corruption. A director of a UN agency said that in some isolated communes (towns), someone could become a mayor at 16 years old even without having gone to school at all. Participants also talked about the fact that the revenues are often *"stolen"* by mayors with no accountability rules (a mining activist and a mining employee). As a consequence, people in fokontanys can be deprived from these benefits; *"this is certainly why fokontanys haven't developed much after all these years"* asserted a deputy mayor near Ambatovy. Worse, given this lack of financial literacy and accountability, the infrastructure that has been built, such as public water pumps, is not maintained and after a while cannot be used, as outlined by several interviewees. Finally, interviewees noted the poor consultation processes mainly around QMM. They said that the consultations

were mostly biased and not representative of the overall regional or local population, even when it was done by CSOs and NGOs. This is why it was recommended for communes that have old Communal Development Plans (PCD in French) to run other rounds of representative consultation to determine the needs of the population as it is now, as it is being done around Ambatovy.

CSOs and NGOs: become bigger, better, and stronger

Eleven interviewees talked about how CSOs and NGOs are essentially stakeholders of the LSM industry and could become considerably more impactful by securing independent funding, ensure the efficiency of complaint mechanisms, and collaborate even more.

A recurrent comment of the interviewees was about the fact that most CSOs and NGOs in Madagascar have restricted funding and the largest ones are funded by mining companies – especially in Fort Dauphin near QMM – as part of their social development commitments. Consequently, these organisations are not independent enough to support the population. *"There is a race to secure funding, no matter where this is coming from"* asserted the head of a CSO. This person added, *"CSOs in Madagascar do more workshops with mining stakeholders and conferences rather than working directly with the community […] There are around 4,000 CSOs listed in the country. If they were seriously doing their job, things would be much better."* Beyond their impact and funding issues, what has been questioned by these interview participants as well is their capacity to work collaboratively. Rivalries to gain funding were cited as the main reason. It was also noted that the Platform of Civil Society Organisations on Extractive Industries (OSCIE in French) regroups 12 organisations, but most of them do not have offices near the mines, which limits their capacity to monitor what is happening and to react quickly.

Mining companies: enhance their developmental role

For the LSM industry to be more beneficial in Madagascar, 23 interviewees suggested that mining companies' approaches need to change. They are *"not a charity nor an aid donor"* as rightfully pointed out an employee at QMM and they indeed need to satisfy their shareholders. Yet, the scope of their responsibilities can be broader to ensure that the

mining revenues are efficiently spent and that communities benefit from their activities, unlike what can be said internally that *“it’s not QMM’s role to support people’s education and access to health care”*. Nevertheless, the mining sector has already started to move beyond CSR *“in a conscious effort to increase benefits”* stated a QMM regional manager. But more could be done to ensure that the consultation process is properly done and that local development plans (PCD in French) are up to date and reflective of current needs in terms of infrastructure development for example. The question of the legitimacy of mining companies in these processes of using mining revenues is central in the thinking of how large-scale mines could further foster economic and social development.

Several interviewees noted the gap in developmental capacity of large-scale mines between when the projects are announced and when these impacts are checked. To manage the population’s expectations, using conservative forecasts would be wiser suggested a few participants. By inflating the positive impacts, the local communities nourish a lot of hope given their state of poverty and thus can only be disappointed outlined a mining activist and a mining expert. This is even more the case in isolated areas where people feel abandoned by the centralised state. *“They tend to expect everything from the large mine. Everything the state should do”,* highlighted a mining academic. A mining expert added, *“since the state doesn’t intervene, the mines are using CSR funds to please and appease instead of spending the funds where they would be most impactful”.* This person also added that *“Madagascar won’t benefit more from mining if the large mining companies and the government authorities at local, regional and national levels don’t work together to get the best possible outcome for the Malagasies”.*

Despite the wide array of stakeholders interviewed, four key recommendations emerged: mining-related information to be transparent and accessible; impacts to be independently assessed; the mining code to be updated; and to increase the benefits for communities

in a sustainable manner. It is worth noting that no matter what their role is, all stakeholders interviewed agreed that there is room for improvement in what has been done in Madagascar with respect to mining activities and their impacts. Their views differed on the scale of what needs changing, depending on whether they benefit directly from mining (e.g., work, mining administration) or they work closer to members of the communities (for CSOs/NGOs etc.).

Therefore, more effort needs to be made by mining companies, governments at all levels and CSOs and NGOs to further support these improvements and address the limitations in the benefits of more than 15 years of LSM, more specifically for youth, women and those in agriculture, fishing, craftsmanship and forestry, who seem to be the ones the most negatively impacted and benefiting the least.

6.4 Study limitations and areas for further research

The novelty of this thesis is to address the need for an objective assessment of the impacts of LSM in Madagascar by using an interdisciplinary approach and combining both qualitative and quantitative data at the national, regional, and local levels. In terms of quantitative data, there are three main limitations related to the secondary data used (Chapter 3 and 4) and primary survey data collected (Chapter 5). More precisely, in Chapter 3, the World Governance Indicators are used with their six components: voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; and control of corruption. The validity of the World Governance Indicators is contested in the literature (Oman & Arndt 2006, Kurtz & Shrank 2007, Razafindrakoto & Roubaud 2010, Thomas 2010). Nevertheless, they were used as they offer a comprehensive report on governance for 200 countries every two years between 1996 and 2002 and annually thereafter. They are based on the aggregation of

perceptions of governance from 31 different data sources provided by 25 different organisations (Kaufmann, Kraay & Mastruzzi 2007), which makes these indicators reliable for comparison of large sample of countries over time.

In Chapter 4, the 2004 DHS survey doesn't have GPS coordinates and therefore could not be used in the DiD analyses. Instead, the 2008–2009 DHS survey is used for "before mining", which was the last DHS survey available in Madagascar at this stage. The latest large-scale survey is the MIS, that was collected in 2016. This has limited the number of outcome variables available in both of the surveys. This is why the variables used are those used for the calculation of the wealth index (assets, housing condition, WASH etc.).

As mentioned in Chapter 5, the sampling framework presented in Table 28 shows that the sample collected is relatively representative of the population composition in terms of gender, employment in mining or formal/informal sector. However, the sample has a greater proportion of people employed than the national average (21% vs 11%) and of people being older (97% of 25-60+ vs 80%). This overrepresentation of these age brackets is due to the selection criteria *"Are you an adult of the household contributing to financial decisions?"*

Despite these limitations related to the quantitative data used, this study manages to highlight what could be done to enhance the benefits of LSM and mitigate its negative impacts. Future research projects could repeat the analysis in a few years to analyse the differences with these findings. By then, the mining industry in Madagascar will be more mature, which should provide more avenues and data to assess the impacts at national level. The recommendations presented in section 6.3 could also inform upcoming research endeavours, such as those linked to the revision of the mining code and the increase of direct benefits to communities (e.g., cash for resources transfers).

The methodology used in this thesis could also be applied in other LMI mining countries where an interdisciplinary assessment of the impacts at national, regional and local levels has not been done yet. Since we find that the size of the investment, the level of disruption of local communities, and the socio-economic characteristics of the area of operation pre-mining may determine the level of outcomes for the local population, future investments in Madagascar and more generally in Low-and-Middle-Income countries could take this into account, especially when planning to invest in poverty-stricken areas. Future research could explore what are the thresholds in terms of investment amount subject to the number of people affected and the existing level of deprivation.

To conclude, the challenges for the Malagasies to benefit more from mining are not specific to this industry. They reveal existing issues characteristic of Madagascar as a whole that could be addressed. To both the promoters and detractors of LSM, this study outlines that whether mining is a blessing or a curse for a country and its population is not binary. Rather, it provides evidence that depending on the level of analysis or the type of outcome considered, the impacts may be considerably different.

These findings offer a diagnosis on the impacts of LSM, but most importantly provide avenues for targeted and concerted improvements for future investments by LSM companies. This evidence can also inform policy-making for governments and institutions, as well as advocacy strategies for CSOs and NGOs. Thus, tailored support could be provided to enhance the benefits of LSM depending on where people live and the extent to which they’re affected by it. As such, this thesis contributes to the growing literature on the resource curse with more nuanced and comprehensive findings, in order to inform more efficient strategies to leverage mining for sustainable development.

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Honours and awards

2019 McKenzie Prize for outstanding early research

2019 RMIT HDR photography competition – Runner-up Prize

2018 RMIT HDR full scholarship for 3 years