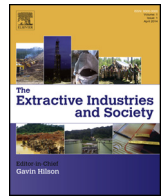




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Original article

Mining and emerging infectious diseases: Results of the Infectious Disease Risk Assessment and Management (IDRAM) initiative pilot

Francesca Viliani^{a,b,*}, Michael Edelstein^a, Emmeline Buckley^c, Ana Llamas^c, Osman Dar^{a,c}

^a Centre on Global Health Security, Chatham House, 10 St. James's Square, London, UK

^b International SOS, Radhuspladsen 16, 1550 Copenhagen, Denmark

^c Public Health England, 133-155 Waterloo Road, London, SE1 8UG, UK

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ABSTRACT

Until recently the extractive industry has been largely unaware of the threat of emerging infectious diseases (EIDs), which have the potential to shut down entire operations. The 2014–15 West African Ebola outbreak changed this, drawing attention to the ramifications of disease outbreaks in terms of both human suffering and economic productivity. The Infectious Disease Risk Assessment and Management (IDRAM) pilot initiative in Katanga, Democratic Republic of Congo, has focused on an assessment of the kinds of risk reduction measures in place among selected companies; the industry's attitudes towards infectious disease control interventions, and; opportunities for collaboration among multiple stakeholders. The initiative found that despite having infection and prevention control measures in place for workers in camps, extractive companies cannot control outbreaks by themselves due to the close interactions with local communities and weak local health systems. Results also showed that EID prevention and control plans benefit both the company and the community and can be feasibly implemented. Consequently, companies should strengthen their risk reduction role by properly assessing the health consequences of their projects through an integrated Environmental Impact Assessment. Finally, partnering with health authorities, other companies, and external stakeholders could help to prepare and respond to infectious disease events.

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1. Introduction

Despite progress during the 20th century in reducing the overall burden of infectious diseases worldwide (Lozano et al., 2012), they remain a significant public health challenge and place a major burden on global economies, especially in low and middle income countries (Dye, 2014; Forouzanfar et al., 2015). Beyond human suffering and community devastation, disease outbreaks have the potential to cause severe social, security, economic and development disruption for affected populations. The economic losses associated with SARS in 2003 amounted to at least US\$80 billion (World Bank, 2012) and the economic impact of the deadly Ebola outbreak in the three most affected countries (Guinea, Liberia and Sierra Leone) is estimated to be at least \$2.2 billion, over 12% of their combined GDP (World Bank, 2015). Indeed the World Economic Forum identified “spread of infectious diseases” as a serious risk factor worldwide in

the report ‘Global Risks 2015’, due to its potentially dangerous and far-reaching consequences (World Economic Forum, 2015).

Extractive industry companies and their surrounding communities are especially vulnerable to such outbreaks. The 2014 Ebola outbreak resulted in a significant downturn in mining activities, as the planned expansion of ongoing projects was halted, the production of several mining companies was reduced, and some companies ceased their operations altogether (e.g. China Union) during the West African Ebola outbreak (World Bank, 2015). Ebola Virus Diseases (EVD) is an example of an Emerging Infectious Disease (EID). EIDs are diseases that have either appeared in a population for the first time, or that may have existed previously but are rapidly increasing in frequency or geographic range or – are old infections re-emerging as result of antimicrobial resistance. Although human history is shaped by infectious diseases emerging in new geographical areas and population groups (McNeill, 1976; Lederberg, 2000), the frequency of EID events over the past several decades has increased (Jones et al., 2008). The majority (60%) of EIDs are zoonoses (i.e. those infections originating from animal reservoirs) and three quarters of these come from wildlife (Taylor et al., 2001; Jones et al., 2008). The link between economic activities, environmental alteration and disease emergence has

* Corresponding author at: Centre for Global Health Security, Chatham House, 10 St. James's Square, London, UK.

E-mail address: Francesca.viliani@internationalsos.com (F. Viliani).

been demonstrated for EVD (WHO, 2015), but several other examples exist. For example, the initial outbreak of the Nipah virus in Malaysia (1998–1999) has been attributed to intensification of pig meat production in, or near to, orchards, coupled with deforestation of the natural habitat for fruit bats (the natural reservoir), increased agricultural production in orchards and climate change (Pulliam et al., 2011; Daszak et al., 2013). The bats passed the Nipah virus to pigs through urine, faeces, and saliva, contaminating the local pigsties (Field et al., 2001). The highly transmissible virus rapidly circulated among the pigs and then was transmitted to farmers and slaughterhouse workers (Chua, 2003, 2010). For these reasons the Institute of Medicine (Institute of Medicine, 2012) called for public–private partnerships between government and the industry to tackle the risks.

The risk of EIDs causing severe disruption is highest in low-income ‘hotspots’ (Jones et al., 2008), especially where surveillance and public health systems are weak; furthermore climate change is altering the geographical presence of vectors and its infectious diseases (Patz et al., 2008). Several of these areas, particularly in the tropics, have increasingly become important destinations for extractive industry operations. These areas are prone to zoonotic disease epidemics and their resultant devastation.

The extractive industry therefore can play a key role in the proactive management of EIDs, not only because of the risk posed by EIDs to their operations (as demonstrated during the Ebola in West Africa) but also because activities associated with extractive industries generate significant environmental, social, demographic, health, and economic changes – all of which are key drivers for disease emergence and outbreaks (Walsh et al., 1993; Morse 1995; Smolinski et al., 2003; Morens et al., 2004; Patz et al., 2004; Wilcox and Ellis 2006; Heymann and Dixon, 2012). These changes put extractive companies on the frontline of such outbreaks. For example, there is evidence pointing to association between the emergence of EVD and forest fragmentation and land clearing (Environmental Foundation for Africa and Foundation, 2015). Forest fragmentation and land clearance can bring potentially infected wild animals, including the bat reservoir for infections like Ebola, into closer contact with human settlements thus causing transmission to people, as occurred in Guinea in December 2013 (WHO, 2015). Current knowledge on the links between biodiversity, ecosystem services, socioeconomic and political factors, and human and animal health is far from complete (Sandifer et al., 2015); however, greater interactions between all these factors appears to increase the likelihood of infectious disease emergence (Weiss and McMichael, 2004).

The Infectious Disease Risk Assessment and Management (IDRAM) initiative was set up as a response to the challenges outlined above and is the first collaborative partner project between industry, academia and the public sector examining these issues.¹ IDRAM has a dual goal to: 1) Increase awareness of

EIDs in the extractive industry, framing the issue in terms of business continuity and risk management and strengthening industry resilience in the face of disease outbreaks, and; 2) Facilitate the extractive industries contribution to national preparedness and response capabilities for EIDs and pandemics, thereby contributing to health system strengthening and improving the sustainability and coordination of disease control efforts in countries where they operate. This paper describes the initiative’s pilot phase which involved a series of activities carried out in Katanga, Democratic Republic of Congo (DRC) in 2014. The pilot was developed as a proof of concept (Thabane et al., 2010; Institute of Medicine, 2012) to explore the feasibility of establishing collaborations among multiple stakeholders to manage EID risks. As such, the pilot included different research, operational, and joint dialogue components, including: a field assessment of preventive measures already in place among selected companies; a qualitative research study explored the industry’s attitudes towards infectious disease control interventions, and; a joint simulated outbreak exercise to foster dialogue among multiple stakeholders. The pilot was based on the ‘One Health’ approach; defined as a collaborative effort of multiple disciplines to attain optimal health for people, animals, and the environment (FAO, OIE et al., 2008). Described is the methodology adopted, key findings for each of the three components, with recommendations for future activities.

2. Methodology of the pilot project

The pilot project carried out in Katanga, DRC in 2014 was conceived as a proof of concept study (Thabane et al., 2010; Institute of Medicine, 2012) exploring the feasibility of collaborations among public and private stakeholders, with a focus on extractive industries, to manage EID risks. The pilot was therefore conceptualised as a simultaneous operational and research project. The objectives were:

- 1) To assess what kind of preventive measures targeting disease transmission at the animal/human interface were already in place at selected mining sites comparing them against international best practices (USAID, 2012a,b). This allowed the team to assess the real practice of infectious disease control in mining operations located in EID hotspots and assess the desirability of partnering with operators for EID management.
- 2) To ascertain the level of awareness about EID risks within the mining sector through a qualitative study. This allowed the team to examine miners’ perceptions of and attitudes toward this new topic and to confirm the interest of mining companies in being a partner in EID management.
- 3) To identify opportunities for collaboration between the mining sector and other stakeholders involved in outbreak preparedness and response. This was done through a series of desktop exercises and ongoing engagement with the industry.

The overall pilot project obtained support from the Katanga Governor and National and Provincial authorities. Four companies with headquarters located in different countries and in different phases of the mining project cycle were chosen for the pilot.

2.1. Field assessment of existing preventive measures at mining sites

Field work was conducted in June 2014 by a team of three experts (two international and one national) to assess the kind of preventive measures targeting disease transmission at the animal/human interface already in place at selected mining sites, and to compare these against international best practices (USAID, 2012a, b). The team visited five projects sites (one mining company was

¹ The partners involved in the pilot phase were Chatham House, Centre for Global Health Security (London) who convened the first meeting, engaged the partners in the dialogue and lead the initiative; USAID who was the project’s principle funding agency and provided the overall framework of reference; International SOS managed the pilot project and provided technical expertise; Freeport McMoran – TenkeFungurume Mine, Tiger Resources – Kipoi Mine, MMG – Kinsevere Mine, and Mawson West – Dikulushi and Pweto Mine: Four mining companies operating in Katanga; Australia-Africa Mining Industry Group (AAMIG) as the industry association that facilitated scaling-up recommendations to its mining company members; FHI 360 and Ecology and Environment, providing subject matter and technical expertise; Provincial government and health authorities in the relevant countries; Provincial and regional academia and professional bodies from Lubumbashi University; National representatives of UN agencies and other international organizations with presence and partners in Katanga, and; the London School of Hygiene and Tropical Medicine and Public Health England as the leading research and public health institutes.

operating two different sites) to carry out rapid appraisals (Rifkin, 1996) using different methods; and mainly: organised meetings with the teams in charge of the areas described in Table 1, and carried out project inspections. The field work was guided by two tools previously developed with USAID funding. One of the tools was a detailed guidance document on how to include EID in the Health Impact Assessment (HIA) process (USAID, 2012a,b); and the second was an audit checklist for existing operational projects (USAID, 2012a,b). The team spent one to two days at each site and its ancillary facilities inspecting main and supporting infrastructure, visiting the concessions, and discussing collectively with over 60 staff members across the sites using the USAID tools to guide questions. The main areas under observation during the field visit are described in Table 1.

2.2. Qualitative study data collection and analysis

A qualitative study was conducted to ascertain the level of awareness about risks from EIDs within the mining sector. The researchers conducted semi-structured telephone interviews with representatives of the four mining sites (in both Katanga and at the mining companies' headquarters) using an interview guide prepared by the project team. This guide contained 17 questions and suggested probes organised around the following topics:

- Introduction/background
- Health in the industry
- Risks and vulnerability
- Mitigation and response
- Barriers and facilitators (to implementing EID guidelines)
- Company policy and priorities

Purposive and snowball sampling (Thompson, 1997), whereby individual respondents suggested other relevant contacts for the study were used to recruit respondents. Initially, 37 people were approached and 18 interviews (3–4 employees per company) were finally conducted. Specific reasons for non-participation were not stated by the people approached. Some cited language barriers (some respondents were French-speaking and interviews were conducted in English), illness or absence from the project site. The study did not include the collection of sensitive personal information. The ethical risks of the study, therefore, were low. Respondents were contacted in advance and given a brief description of the research and the informed consent form. At the start of the interview respondents were given again the necessary information to provide informed consent and were reminded that their participation was entirely voluntary. The study proposal was reviewed and approved by the Ethical Board of the Lubumbashi University. The responses were coded and the data reported were not attributed directly to the respondents.

'Broad brush' coding was conducted in the first instance, whereby key themes were identified and labelled. The themes

emerging from the data were defined and subsequently used to refine the thematic coding and to identify new themes and relationships between each code. Deviant cases (disconfirming cases) were analyzed to maximize the rigour of analysis, a common strategy in qualitative research (Green and Thorogood, 2004). Finally, the research team discussed their individual analysis and overarching findings; interpretation disagreements were resolved by consensus to produce a comprehensive account of the main research findings (Green and Thorogood, 2004).

2.3. Desktop exercises

The desktop exercises were designed to identify the opportunities for collaboration between the mining sector and other stakeholders involved in outbreak preparedness and response. The exercises simulated an outbreak of viral haemorrhagic fever (Marburg Virus) in the southernmost province of a fictional central African state: the Democratic African Republic. Participants were provided with a realistic, fictional scenario about a rapidly evolving disease outbreak, and worked in small groups to decide how best to respond. The Emergency Response Division of Public Health England (PHE) developed the scenarios with inputs from the main team. The simulation exercises were designed to help identify existing levels of preparedness of each actor invited, and simultaneously test the feasibility and acceptability of developing joint plans and procedures.

The exercises were conducted twice: Kulinda Afya² I was run in Lubumbashi, DRC (11 August 2014). Kulinda Afya II was run twice at the Africa Down Under Conference in Perth, Australia (4–5 September 2014). Twenty-eight people attended the exercise in Lubumbashi, including representatives from the provincial health authorities and mining companies in Katanga as well as the University of Lubumbashi, NGOs and UN Agencies. Thirty-nine people representing mining companies, government and NGOs attended the two workshops at the Africa Down Under Conference.

3. Results

3.1. Field assessment of preventive measures for infectious disease management

The first part of the project consisted of an assessment of the kinds of preventive measures targeting disease transmission at the animal/human interface already in place at selected mining sites, and compared them against international best practices (USAID, 2012a,b). Having preventive measures already in place was deemed a fundamental pre-requisite for any further collaboration between private and public actors and consistent with an integrated and intersectoral approach to EID management (UNEP, 2016). In general it was found that the companies in the pilot were

² Swahili for 'Protect our health'.

already implementing most of the recommended preventive actions included in the USAID tools. For example, in terms of nuisance animals and biodiversity, none of the facilities visited in the five projects had significant problems with nuisance animals, and all projects had some form of weekly control for mosquitoes and vermin. Each mine had a biodiversity management program, primarily focused on preserving appropriate flora biodiversity. All projects had 'no hunting' policies which were enforced on-site and within the facility; however, the mines had no way to enforce the no hunting policy off-site. In general, the mine and the associated facilities had a small footprint within the overall concession, which could include multiple cities and villages.

Table 1

Areas assessed in terms of policies, procedures, management plans.

Main Areas assessed	Specific areas assessed
Nuisance Animals Management/Control	
Bushmeat Control	
Biodiversity/Biological Resources	
On-site Infrastructure:	Worker accommodation
	Canteen/food safety/food security
	Drinking water safety
	Sanitation/waste management
Worker Health	
Community Health	
Impact Assessment Process	

In terms of on-site infrastructure, all mining companies provided housing to their expatriate and some Congolese staff. Housing and maintenance met international standards. Those living in nearby communities were bussed to the site. Access to clean water was a problem for many communities in Katanga Province. At the time of the pilot, on-site potable water was pumped from boreholes, stored in tanks, and distributed throughout the camps after being treated with chlorine. All facilities regularly tested their water supply, and were checked regularly for the presence of stagnant water. All sites used septic systems; some with leach fields, and others pumped their septic tanks regularly. Waste was managed appropriately. All canteens used Hazard Analysis Critical Control Point (HAACP)-type protocols. Several canteen managers set up programs in the surrounding communities to increase the quality and quantity of food that could be purchased locally.

The extent of general medical care varied from site to site. All expatriate workers were vaccinated for Yellow Fever as a compulsory requirement in country. Only a few vaccines are maintained and provided at the project level, primarily: tetanus, rabies, and hepatitis B. We could not ascertain the vaccination status of national staff. Emergency care and stabilization was provided at all sites, and all medical facilities at project level could test and treat malaria. Some projects had sophisticated surveillance systems to monitor workers health and ensure adequate medical care was provided in case of need. Some health messages about the main risks were also included in the safety inductions of workers, although these tended to focus on known local health risks such as malaria and HIV. All sites had risk registers and an emergency response plan. It was not possible to ascertain how many projects had any health issues included in their risk registers, but one project had cholera as a risk, requiring active monitoring and another had a pandemic plan.

Health programs for the local communities varied in terms of their nature and breadth. All mining sites had refurbished the local hospital or main health centre to some extent and provided logistical support to the local health teams. Some sites had extended and comprehensive community health programs in full coordination with the local health zone³ and provincial departments. For example, one company was supporting an integrated vector control program in accordance with the national DRC guidelines across the whole concession (ICMM, 2013). Community health programs also involved health promotion campaigns. Finally, all sites supported the local health zone in response to health emergencies such as cholera or measles outbreaks. One company mentioned that the health zone contacted the mining site as soon as cholera cases were identified and they jointly supported outreach activities through health volunteers in the communities. In another instance, a mining company provided the material needed to set up a cholera treatment centres as well as Personal Protective Equipment (PPE). Staff at one project mentioned that the local veterinary department had previously detected an unknown outbreak in poultry for which farmers wanted support, however, the department did not have access to diagnostic test or vaccines, so the outbreak progressed unknown and untreated.

All projects visited had already carried out and submitted an Environmental Impact Assessment (EIA) report for projects in operation. The DRC's Mining Code (Loi n 007/2002 du 11 juillet 2002 Portant Code Minier) and the Mining Regulation (Décret n 038/2003 du 26 mars 2003 Portant Règlement Minier) provide the legal framework for mining operations in the DRC. The Annex IX of

the mining regulation obliges mining exploration and projects to perform an EIA and public consultation. In July 2011, the DRC government enacted the Environmental Framework Law (Loi n°11/009 du 09 juillet 2011) that articulates the principles for the management and protection of the environment. The law also extends the environmental regulatory framework to include a social component in the assessment process. The team did not review any of the EIA or Environmental, Social, and Health Impact Assessment (ESHIA) reports, and therefore no information is available on the coverage of EID risks in these reports. The fact that all projects visited had already carried out and submitted an Environmental Impact Assessment (EIA) report for projects in operation, confirmed the possibility of using these processes in future to identify risk factors for infectious disease transmission.

The benchmark of international best practices for infectious disease control used during the field work were based on the "One health" concept, promoting a combined animal-human-ecosystem approach to disease preparedness, mitigation and response. However, mining projects do not necessarily use a One Health approach and therefore the links between recommendations outside of the immediate health domain, and the associated benefits for infectious disease management were not immediately evident to the staff consulted. For example, the medical teams were not concerned or knowledgeable about the biodiversity programs implemented by their projects, nor about the important role that ecosystem integrity plays in disease prevention. Similarly, the environment teams were not involved in the canteen inspections, neither were they necessarily aware of the importance of proper food handling in deterring wild and nuisance animals from the project. Both biodiversity programs and canteen inspections are essential for reducing the risk of transmission and were correctly implemented in the project sites, but the linkages between the different elements were not recognised across teams.

Finally, the staff consulted felt that their management processes for infectious disease control 'inside the fence' were optimal. However, all stressed the difficulty (or impossibility) of controlling the area outside of the project facilities, namely the wider concession area and the communities living at, or close to, the site. The dynamic and unpredictable nature of surrounding communities not only made it challenging for companies to implement their infection control plans, but also increased the possibility of the introduction of new infection risks. The mining companies and staff involved in this pilot recognised "outside the fence" areas as a key vulnerability for business continuity in the case of an outbreak.

3.2. Qualitative study

The results of the qualitative study provided an indication of current preventative measures in place in the selected mining companies, the types of medical services available to miners and the surrounding communities, and attitudes among respondents to implementing Infection, Prevention and Control (IPC) measures. Certain representative quotes from the interviews have been included in the results to illustrate the views expressed by respondents and highlight the main themes that emerged from the study.

The main diseases perceived and reported by study respondents as being health threats were those with the higher epidemiological burden in the area, such as malaria, respiratory tract infections, and diarrhoea. Most of the health programs supported by companies in the study focused on HIV/AIDS, tuberculosis, malaria, and diarrhoeal diseases. The perceived close relationship between workers' health and that of the community, alongside commitments to corporate social responsibility (CSR), were key motivating

³ In DRC the health district is defined health zone. The health zone is the main operational level of the national health system

factors for mining companies to invest in community health programmes. However, the scale of investment varied greatly among the four companies.

3.2.1. Current preventive measures

The mining companies in this study had appropriate IPC measures within their facilities. For respondents, health promotion was a key strategy in preventing and controlling disease outbreaks, and most activities targeted the workforce exclusively. According to respondents, providing information was the main strategy used in health promotion. This was undertaken via talks, movie nights, providing visual materials, and also demonstration sessions to teach staff relevant skills.

Respondents described workers' accommodation as being clean, in good condition, and generally appropriate. An important factor that influenced workers' accommodation was the company's development phase. During the initial exploration phase, some respondents indicated that accommodation and sanitary facilities were very basic. Hunting or consumption of bushmeat was strictly forbidden in camps in order to avoid contracting diseases and to protect biodiversity. Despite this, respondents noted that workers could still be exposed to bushmeat in the community, and thus contract diseases, which respondents argued was beyond the company's control. According to respondents, mines had biodiversity plans built into their existing management system; these were part of the DRC requirements for obtaining a mining licence, as well as their commitment to meet international standards, and fulfil their CSR obligations. Respondents pointed out that while mines made efforts to preserve biodiversity, these were somewhat futile due to the fact that the recent civil war and the extreme poverty of surrounding communities had put a significant strain on the environment. One Community Development and Social Responsibility Manager remarked:

We don't see any primates in our area in DRC. I think everything has been eaten, unfortunately (. . .). I've noticed that where the mine has developed and local communities have been resettled, we do see an uptick in wildlife coming into our mine area, because actually there is no hunting going on in those areas and [animals] are protected. So maybe someday we'll see a return of primates, but we don't at this point

Respondents questioned the adequacy of EIA as a means of identifying impacts and developing appropriate management plans. Some respondents highlighted how EIAs can become a tick-box exercise rather than a properly considered process. As one respondent said:

[In a previous job] I managed to get an environmental impact assessment done for twelve and a half thousand dollars, and the guy spent the sum total of one hour on-site. Now, there are some companies that work that way, and there are other companies that don't. [My current company] is one of the companies that doesn't work that way.]

Overall, respondents reported having comprehensive and effective systems in place to prevent and control disease outbreaks in camp. However, respondents acknowledged that outbreaks in the community had the potential to bring mining operations to a halt. Thus, most agreed that collaborating with other stakeholders and strengthening local health services to prevent and control EIDs was in "everyone's best interest". Results indicate that mining companies have had significant experience in preventing and controlling diseases outbreaks both in camps and the community.

3.2.2. Medical services

Free medical services were available on site for employees and their dependents. These were mainly primary health clinics, but

there were also referral arrangements in place for more serious conditions. Results indicate that mines had good links with surrounding communities due to the ongoing programmes they supported and through workers from local communities. Moreover, mining companies were strengthening local health systems through epidemiological surveillance. According to respondents, mines were required to register the occurrence of notifiable diseases in camp and report these to the Ministry of Health. Thus, given their location, the resources available to mines, and their relationship with surrounding communities, mines appeared to be in a good position to investigate rumours and conduct early outbreak management. The interaction of mining medical services with the local health system and other stakeholders is illustrated with this statement from one of the medical advisors:

We've had a recent polio epidemic that affected large parts of Katanga. We arranged to have a mass polio vaccination campaign, organized partly through the government, provincial medical services and other NGOs, Medecins Sans Frontiers and so on. We have occasionally measles epidemics. Again, these [outbreaks campaigns] were organized and sorted out and we haven't had any more measles for a couple of months now.

Mining companies had easy access to expert health advice. For example, respondents recalled being issued updated guidelines to manage potential Ebola cases. However, one respondent's account showed that a lack of managerial support at the local level as well as appropriate links to the health system can thwart effective prevention and management of outbreaks.

3.2.3. Barriers and facilitators to implementing infection prevention and control measures

This study revealed a number of perceived barriers and facilitators for implementation of IPC measures, including for EIDs, within the mining industry. Barriers included the use of disease prevalence as the main criterion to inform health programming; the costs and feasibility of implementing measures; weak local health systems and infrastructure; as well as poor governance in the host country. Factors that facilitated the implementation of IPC and EID measures included perceptions of vulnerability to the external environment in which mining companies operated; a sense that these measures made economic sense; a commitment to comply with international standards and CSR; as well as the existence of strong management structures and systems. Two factors increased awareness of EIDs during the qualitative study; one was the unfolding of Ebola outbreak in West Africa, the other was the outbreak simulation exercise organized as a part of the pilot project.

Respondents' accounts highlighted an existing tension regarding the role of mining companies and that of the State with regard to improving health in the communities surrounding mines. Respondents agreed investment in the State was worthwhile however, health was seen as primarily the government's responsibility. One of the respondents summarised this widely expressed sentiment with the following statement:

I think people will say, 'Look, I'm here to mine and I'm not the government. I can't control, regulate, every animal and every person so people are responsible for themselves and there's the government here that should step up.

Other respondents noted that health issues in general were beyond their scope and expertise, which limited their involvement in the control and prevention of EIDs. Interviews showed that respondents' views and attitudes towards IPC measures appeared to have been influenced by their professional role in the mining company. For example, several respondents made a distinction between "traditional (or real) miners" and those non-traditional

miners, such as health workers and community development managers. A final and major theme to emerge from the interviews was a sense of despair about the state of health systems and infrastructure. Respondents described a shortage of isolation facilities, healthcare workers, and equipment.

3.3. Desktop exercises

The aim of the Kulinda Afya exercises was to raise awareness of the risks presented by an infectious zoonotic disease outbreak among representatives of the extractive industries, and to identify the opportunities for collaboration between the mining sector and other stakeholders involved in outbreak preparedness and response. Participants of the Kulinda Afya I exercise were divided into four groups based on the location of their workplaces. Each group contained representatives from a mining company and human and animal health experts in order to contextualise the generic exercise in the health zone where the project was located. All groups reported that the medical system in Katanga province and the DRC had in place arrangements that would enable the authorities to respond to an outbreak such as that described in the exercise scenario. However, participants highlighted that the existing health system suffered from a paucity of resources and capacity. All groups also reported that the procedures in place in the mining facilities represented at the exercise would have been adequate to guard against and deal with the risks presented by the scenario.

The Kulinda Afya II exercise was designed to help participants consider how the industry operating in Africa can better meet its duty of care to employees and the surrounding communities by helping them plan how best to counter the challenge of new and emerging infectious diseases. This exercise also helped companies to assess their preparedness to respond to any health emergency and their potential to collaborate with each other and with the host government. There was agreement that mining companies had arrangements in place to mitigate the risks and effects of some illnesses in the areas in which they operate. However these arrangements tended to be narrowly focused on the risks to mining sites and staff.

Participants in both exercises agreed that current arrangements could be enhanced in a number of ways:

- An outbreak management plan should be an integral component of the emergency response plans of mining projects in order to support business continuity plans;
- Increased collaboration between the companies, communities and provincial health and veterinary authorities in preparing and responding to an outbreak.
- More emphasis should be put on developing the relationship between the mining companies and surrounding communities when considering an outbreak response and noted that developing health education and communication with communities may contribute to protecting the health of mine employees.
- Acknowledging the shortage of resources for dealing with a zoonotic disease outbreak, all actors should better share the resources currently available.

4. Discussion

The results of this pilot project suggest that multinational companies, including those in the extractives sector, could play a unique and valuable role in reducing the risks of infectious disease transmission, and improve the management of potential outbreaks. The field assessment confirmed that all mining companies

visited have preventive measures in place for controlling infectious disease and managing possible outbreaks. The qualitative study showed awareness among mining companies staff on the risk posed by EID and willingness to collaborate with other stakeholders to manage the risk. Finally the desktop exercises concluded that increased collaboration is beneficial, not least due to the limited resources available. The areas in which the extractive sector could offer added value include:

1. *Risk reduction and prevention*: by assessing projects to ensure they are designed to reduce the interaction between wildlife, livestock, and the human population.
2. *Preparedness and response to health emergencies in collaboration with multiple stakeholders*: by extending existing processes ‘inside the fence’ to ‘outside the fence’ (i.e. with local health and veterinary authorities and other private sector stakeholders in the region), and towards structured partnerships with additional multiple actors in case of outbreak management (e.g. NGOs, CBOs, security services, etc.).

4.1. Risk reduction and impact assessment

The mining companies involved in the pilot project carried out EIAs prior to commencing or expanding their projects. EIA occurs at the project design phase and could include a community health and safety component. When these assessments are conducted, many companies actively mitigate the potential adverse effects of their operations on wildlife and promote biodiversity, but often do not consider the potential transmission of zoonotic pathogens, and the capacity of the local public health system. Furthermore, all the companies included in the study followed the International Finance Corporation (IFC) Performance Standards (PS) and two of them were also members of the International Council on Mining and Metals (ICMM). IFC PS number 4 focuses on “Community health, safety and security” (IFC, 2012) and IFC has developed a guidance on HIA (IFC, 2009). ICMM has also a guidance on HIA (ICMM, 2010) as well as a series of recommendations for mining projects on managing risks associated with malaria, tuberculosis, and HIV/AIDS (ICMM, 2008). In general however, health at large is usually poorly covered in the EIA process unless a comprehensive HIA is carried out (Winkler et al., 2011; Viliani and Clarke, 2013; Harris et al., 2015).

Therefore, the EIA process should look more closely at the long-term, or residual consequences that changes to environment, biodiversity, ecosystem services, and social structure could have on human health. Consideration should also be paid to the fact that the different teams operating on a mining project are often not familiar with the activities carried out by other departments, and therefore not aware of the long term consequences of some of all actions – as demonstrated by the pilot. Table 2 briefly describes how changes brought about by mining projects (impact issues) can lead to increased EID risk.

4.2. Collaborations in preparedness and response

All mining projects involved in this pilot had emergency response plans and risk registers in place,⁴ and collaborated with local health authorities in the case of an outbreak. The level of collaboration and exchange among stakeholders varied across the five projects, and ranged from the provision of ad hoc support to the local health centre for the management of a single outbreak

⁴ One company even had a pandemic response plan focused on the ‘inside the fence’.

Table 2

Typical health impact issues associated with zoonotic disease transmission (adapted from (USAID, 2012a,b)).

Impact	Effect	EID issues leading to disease transmission risk
Influx (job seekers, family, service workers, camp followers)	<ul style="list-style-type: none"> Increased population/density. Stresses community infrastructure. Immunologically susceptible migrant population. Introduction of disease carriers not present in the area. 	<ul style="list-style-type: none"> Increased personal contact. Increased potential for evolution and/or amplification of disease. Altered immunological susceptibility. Altered epidemiological profile. Host transfer.
Resettlement/ Relocation	<ul style="list-style-type: none"> Existing social/community structures altered. Land use change. Peri-urban influx of hunting/gathering populations. 	<ul style="list-style-type: none"> Increased personal contact. Altered immunological susceptibility. Increased proximity of animals and humans.
Water Management (Including creation of new water bodies, altering existing water bodies, and changes in drainage patterns)	<ul style="list-style-type: none"> Modified/created insect habitats. Modified/created animal watering areas. Increased stress on, or competition for, water resources. Altered habitats from increased water pollution. 	<ul style="list-style-type: none"> Wildlife/vectors contaminating food and water storage. Increased shared water use potential between humans and wildlife. Changes in (intermediate) host population density. Altered quality/quantity of community water available.
Linear Features (roadways; transportation routes; transmission lines)	<ul style="list-style-type: none"> Increased access to remote undeveloped areas/niches. Increased bushmeat hunting. Increased land use change. Modified existing habitats. 	<ul style="list-style-type: none"> Increases human-wildlife contact. Potential consumption of nuisance wildlife meat and their fluids.
Infrastructure/Facilities (including on-site housing, catering laundry, sewage, and containment facilities)	<ul style="list-style-type: none"> Attracts nuisance wildlife to sewage, water, or food facilities. Increased rodents/bat habitat. Increased habitat pollution. 	<ul style="list-style-type: none"> Increase in potential human-wildlife/vector contact if buildings are not sufficiently wildlife/vector proofed.
Habitat Fragmentation, Edge Effect, and Biodiversity Loss (due to the population influx, labour camps, and construction of linear features and facilities)	<ul style="list-style-type: none"> Modification of existing habitats. Loss of predator species. Wildlife may seek food and shelter in human settlements. Soil erosion. 	<ul style="list-style-type: none"> Increase in human-wildlife contact. Host transfer
Agricultural Production (including nuisance wildlife, land clearing, and food and waste storage)	<ul style="list-style-type: none"> Modification of wildlife habitats. Provision of food for wildlife. 	<ul style="list-style-type: none"> Increase in human-wildlife contact. Increase in wildlife-livestock contact and disease transmission. Host transfer

event, to a fully formalised collaboration with the health authorities including a health system strengthening component. However none of the projects had joint or shared preparedness and response plans. Emergency preparedness is essential to mitigate the consequences of crises and to ensure business continuity. State governments bear the primary responsibility for protecting their populations and responding in the case of health emergencies (WHO, 2005, 2007). However, a more effective approach to preparedness should extend well beyond the state to include all stakeholders including the private sector (United Nations and World Economic Forum, 2008; Salcito et al., 2014; UNISDR, 2015). During the Ebola outbreak in West Africa, an extensive range of interventions were supported by the private sector (e.g.: educational program for communities, logistic and transport support, development of 'Ebola-proof' tablets, research for Ebola drugs and vaccines) (World Economic Forum and Boston Consulting Group, 2015).

The results of this pilot study show that the companies have developed over the years, sophisticated 'inside the fence' health and safety systems for protecting their projects and the workforce. All projects included in the pilot were already implementing the procedural recommendations suggested in the tools (USAID,

2012a,b), including health surveillance for their workers and provision of medical care and health education. Companies generally felt in control of their internal management processes as shown by the qualitative study results, but all stressed the difficulty (or impossibility) of controlling the area outside of the project facilities, namely the wider concession area and the communities living at or close to the site.

Over the last ten years companies have extended their sphere of responsibility, giving more attention to the health of the communities living in proximity to their operations (ICMM, 2013; Mitja et al., 2013; Dery et al., 2015; Silva et al., 2015). All companies involved in the pilot – regardless of the comprehensiveness of their sponsored community health programmes – promptly assisted the district health zone team to respond to local outbreaks in order to promptly and efficiently control the infections. There is no rigid separation between workers and the community in any of the projects included in the pilot as a significant portion of the workforce originates from, and interacts with, the community. In addition, the project areas and the surrounding environment are never fully fenced. Consequently, healthy communities offer the best protection for the workforce and their protection and health promotion should not be

considered mere CSR, but a key project strategy (Harvey, 2014). Workers at the mining projects visited were all exposed to health and safety inductions and programs, and – as such – were considered a positive force for change in the local communities, bringing home health messages about the outbreak risks; and strengthen these messages was one of the key recommendations emerged by the desktop exercises. These workers have the potential to create a form of dialogue between the mining company and the community. Moreover, workers originating in the local communities could help external actors to assess and frame local risk practices in order to shape and target specific health messages. This could be critically important for strengthening community sensitization during an outbreak⁵ (Abramowitz et al., 2015).

Finally, timely outbreak detection in both wild or domesticated animals (Bisson et al., 2015) and human populations (Berkelman et al., 1994), in and around mining concessions and communities could be an effective mechanism in reducing the risks of outbreak. A change in local conditions induced by the project can alter the epidemiological profile of the area and generate new health risks for the workforce, as well as for the wider community. The capacity of the local health system to collate, analyze, and respond to the notifications of events was found lacking during the pilot and was mentioned by the mining companies' staff in the qualitative study. This is an area where additional support from the mining companies would strengthen their risk management system. This is particularly important as mining operations are often based in remote locations where the risk of infectious diseases is high, and the capacity to detect them is low.

5. Conclusions

The IDRAM pilot was developed as a proof of concept to explore the feasibility of developing collaborations among multiple stakeholders to manage EID risks. As such the pilot included research, operational and joint dialogue components. The results confirmed that the private sector, and in particular the mining sector, can be an important partner in EID prevention, preparedness, and response. The main rationale for collaborations among multiple stakeholders is based on the high economic costs associated with uncontrolled epidemics. The impact of Ebola in the three most affected countries has been estimated to be at least \$2.2 billion (World Bank, 2015). The socio-economic impacts extend beyond the macroeconomic country level, and examples of far-reaching ramifications include job losses, financial hardship, food insecurity, reduced access and use of public services, and an increase and neglect of other infections (United Nations Development Programme, World Bank et al., 2015). This situation is detrimental for the people, the countries where they occur and private companies operating the region.

The pilot project demonstrated that companies often have good measures in place for the control of infectious disease transmission 'inside the fence', but lack the same capacities 'outside the fence', even within their own concession. While companies have direct control over the 'inside of the fence' measures and context, the "outside the fence" is beyond their direct control. Factors such as migration flows, bushmeat sale and consumption, hygiene practices, and the ability of local health systems to respond to

outbreaks are indeed beyond the control of individual actors and limit the capacity of mining companies to prevent and control EID outbreaks. The sector has acquired over the years the following competencies that could be critical to prevent and manage an outbreak and should be leveraged in multi-stakeholders collaborations:

- Strong Health, Safety, Environmental (HSE) management cultures, systems, and practices that can readily include awareness for EID management;
- Well-functioning health services for the workforce located in close proximity to project operations (therefore, adaptable for surveillance, if and when required);
- Availability of human resources (health and others), and capital for the EID management;
- Previously developed pandemic preparedness plans (mainly targeting influenza), and an awareness of the generic risks associated with managing a pandemic;
- Mining operations have strong commitments and willingness to develop community capacity-building initiatives as part of their CSR and community engagement programs.

Furthermore there are clear benefits to the extractive sector in gaining a better understanding of the changes generated by their mining projects, as these changes could trigger events critical for business continuity. The socio-ecological factors associated with projects development are interlinked, but how they alter each other is not always clear, these are nevertheless influencing disease emergence and transmissions. Therefore, mining projects should not merely rely on their internal health and safety systems, but should carefully assess the capacity of the local health systems to prevent and manage outbreaks; as well as the interlinkages between land use change, socio economic development, ecosystem services, and disease control through an integrated EIA with a strong focus on health and including zoonotic infections.

Finally, the extractive industry cannot work unilaterally, and national and local health authorities need to be enabled and empowered to work with the private sector. Generally, neither governments nor the private sector have a strong history of partnerships on public health issues, similarly none has an in-depth understanding of the sector's institutional culture. Collaborations on outbreak management can be facilitated with the support of international organizations focused on strengthening 'One Health' systems and supporting sustainable development. A 'collaborative partnership' approach is the cornerstone for the achievement of the Sustainable Development Goals (SDG) (United Nations, 2015), and aims to ensure universal access to health, and accelerate the pace of progress in fighting diseases and epidemics. Impartial support of international technical experts provide the reassurance to all sectors that their concerns and priorities are being adequately addressed and reflected in joint collaborations. With these elements in place, improving EID control is achievable and in the best interests of all stakeholders, especially of countries rich in minerals and interested in maximising the positive values and minimising the harms associated with mining activities.

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⁵ Lack of trust towards government, foreign health workers, media, and the international community in general – coupled with health messages with a biomedical focus – were partially responsible for the delayed effectiveness of Ebola control interventions (from Oosterhoff and Wilkinson, 2015). Local Engagement in Ebola Outbreaks and Beyond in Sierra Leone. Brighton, UK, Institute of Development Studies.

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