The GCRF Mine Dust and Health Network: A Collaborative Engagement Platform

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ABSTRACT

Fugitive dust from mineral extraction and processing activities can significantly influence air quality, the environment, and the health and quality of life of workers and surrounding communities. Poor engagement and communication between experts and lay persons, disciplinary silos and polarised viewpoints have made it difficult to develop a holistic understanding of the complex health issues associated with environmental emissions of mine dusts, and consequently to design meaningful and integrated approaches to address such issues.

The collaborative Global Challenges Research Fund (GCRF) Mine Dust and Health Network, hosted by Minerals to Metals at the University of Cape Town, serves as a collaborative think-tank to inform research directions within and across disciplines, government policy and regulations, health monitoring programmes at public clinics, industry best practice, community healthcare and impact prevention programmes. It focuses initially on the southern African region, but with the intention to expand to mining-intensive developing countries within the rest of Africa, South America and Asia. This paper outlines the approach and activities of this global transdisciplinary and intersectoral network and presents some of the key outputs and achievements to date.

Keywords: Mine dust, Global Challenges Research Fund Mine Dust and Health Network.

1. Introduction

The mining industry has the potential to be a significant contributor to the economies of developing countries around the world. However, the activities associated with this industry often have significant adverse impacts on the surrounding environment and local people. One issue that is increasingly being recognized as a major concern is the dust emitted by mining and its associated

operations. Fugitive dust from mining activities can significantly influence air quality, the environment and the health of workers and surrounding communities (Csavina *et al*., 2011 and 2012; Kribek *et al*., 2014; Matzenbacher *et al*., 2017; Andraos *et al*., 2018).

Coal and gold mining, for instance, have been strongly associated with occupational exposure to dust and the development of related lung diseases (Petsonk *et al*., 2013; Knight *et al*., 2015; Utembe *et al*., 2015; Ehlrich *et al*., 2018). This association has recently been recognized in a class action lawsuit against the six main mining houses in South Africa, awarded in favor of mine workers who contracted the lung diseases silicosis and tuberculosis (TB) working on gold mines between March 1965 and May 2018 (https://www.silicosissettlement.co.za/). The wind dispersion of particulates from mining activities and waste dumps, furthermore, can give rise to widespread environmental alteration and contamination of soils, flora and fauna in the local environment, and also cause adverse health effects to communities living in the vicinity of the mines through exposure to potentially harmful contaminants as a result of inhalation, ingestion of contaminated soils or food sources, and dermal contact (Patra *et al*., 2016). Media reports on mine dust pollution in Saldanha in South Africa; Lamberts Point in Virginia, USA; Tubarao in Brazil and Esperance in Australia have, furthermore, shown that the transport and stockpiling of mined ore can result in the dispersion of mine dust with adverse effects on communities along roads, railway lines and near harbor terminals, hundreds and even thousands of kilometers from the mine or processing plant. Whilst these mine dust-related impacts have not been limited to disadvantaged communities alone, a recent study of the area completed by the International Human Rights Clinic at the Harvard Law School (IHRC, 2016) has highlighted the fact that poor and disempowered communities more often than not bear the brunt of the pollution impacts (http://hrp.law.harvard.edu/wp-content/uploads/2016/11/The-Cost-of-Gold-Full-Report-Final.pdf).

In contrast to occupational health outcomes, the health effects associated with environmental dust emissions, have not been rigorously studied, and large gaps in knowledge still exist. This is partly due to the complexities involved, with the source-response relationships being decidedly non-linear and influenced by a number of inter-related factors covering the economic, social, geological, environmental, engineering, management, political and health sciences. The issues associated with mine dust are also frequently contentious and involve a number of stakeholders and interested and affected parties with different, and often conflicting, priorities. Poor engagement and communication between experts and lay persons, disciplinary silos and polarised viewpoints have made it difficult to develop a holistic understanding of the complex health issues associated with environmental emissions of mine dusts, and consequently to design meaningful and integrated approaches to address such issues.

It is these challenges that the Global Challenges Research (GCRF) Mine Dust and Health Network (www.minedust.org) seeks to address, by bringing together researchers, stakeholders and practitioners from a variety of disciplines and professional backgrounds to identify sources, challenges and potential mitigation opportunities associated with public health effects from dust pollution arising from mining

activities (including ore extraction, beneficiation, transport and stockpiling). This paper outlines the goals, approach and activities of this global transdisciplinary and intersectoral network. Key findings and achievements to date are also presented.

2. Network description

2.1. Aims and objectives

Funded by the United Kingdom Global Challenges Research Fund (GCRF) and hosted by the University of Cape Town's Minerals to Metals initiative, the Mine Dust and Health Network serves as a collaborative platform, bringing together a raft of experts and affected parties from a range of mining-intensive countries to provide a broad and inclusive range of perspectives to the complex problems associated with mine dust. The focus is on integrating and sharing knowledge and information across different disciplines and stakeholders on research directions within and across disciplines; government policy and regulations; health monitoring programs at public clinics; industry best practice; as well as community healthcare and impact prevention programs.

The Network's specific objectives are to: (i) facilitate a shared and common understanding of the inter-related health risks and mitigation opportunities relating to mine dust exposure, by creating safe spaces for open discussion by all stakeholders; (ii) develop interdisciplinary research capacity, particularly among early career researchers in developing countries, to provide meaningful inputs to collaborative problem solving and to propose integrated solutions relevant to specific country/population contexts; (iii) increase community and regulatory awareness of mine dust related health risks and mitigation measures to devise low-cost solutions and include previously voiceless communities as part of the problem-solving team, and (iv) expand its sphere of influence and attract further funding by increasing the network membership and connecting with other relevant networks and GCRF Challenge Leaders.

2.2. Structure and management

The GCRF Mine Dust and Health Network builds on the current University of Cape Town (UCT) "mine dust networking group" which was established in 2016 to address perceived positions of distrust and competing interests among different stakeholders relating to mine dust. The mine dust networking group succeeded in bringing together more than 20 university academics from diverse disciplines, as well as representatives from local industry, consultancies specializing in mine dust management and monitoring, local and national government, community support organizations and state-owned enterprises. Under the auspices of the GCRF Global Engagement Networks program, this network will be expanded to extend beyond the UCT and South African stakeholders, initially incorporating existing contacts of the mine dust networking group within United Kingdom, Namibia, Zambia, and

Mozambique, and eventually extending to other mining-intensive developing countries in the rest of Africa, South America and Asia. Stakeholders will include, for example, communities and mineworkers affected by mine dust, the industry that is both providing employment to the communities and creating the dust, and governmental institutions that are responsible for regulating and implementing solutions to the dust problem.

A three-tiered network structure (Figure 1) will be adopted in order to manage conflicts of interest and create "safe" and productive spaces in which members can communicate and function effectively, whilst also to assisting in bridging the gap between experts and lay persons. The Tier 1 multi-stakeholder "forum group" will comprise all interested and affected parties (encompassing representatives from academia, industry, community, government, and business) to share concerns, challenges and experiences, and to debate potential solutions and research directions. Tier 2 will consist of interdisciplinary "special interest groups" of researchers and independent experts to enhance awareness of cross-cutting linkages spanning the disciplinary fields, and to promote the design and development of interdisciplinary research and outputs. The forum group will thus serve the purpose of informing the special interest groups of key concerns, perspectives and experiences of the broader society, while the interest groups will provide factual evidence and specialist knowledge to inform the forum debates. From these two tiers, a third tier of smaller working groups will be allowed to emerge, to focus on specific outputs (Tier 3, Figure1) and to monitor the impact of the network's activities. Network members will be nominated and elected to lead the various special interest groups and task working groups in accordance with the structure outlined below.

Fig. 1: Tiered network structure

The Network is headed by the mine dust networking group founding lead, Associate Professor Jennifer Broadhurst (as Director), who is supported by Associate Professor and occupational medicine specialist Shahieda Adams, an occupational medicine specialist, as Co-Director and Dr Johanna von Holdt as network manager. Six core network members, chosen for their leadership skills, cross-cutting expertise, and passion and commitment to addressing this challenge, form the Network's steering group. These members include Dr Jewette Masinja (School of Mines, University of Zambia), Prof Giles Wiggs (University of Oxford, UK), Dr Matthew Baddock (Loughborough University, UK), Dr Mazimkhulu Zungu (School of Health Systems and Public Health, University of Pretoria and previously Acting Director, South African National Institute of Occupational Health), Dr Brian Chicksen (Specialist physician and former Vice President Group Sustainability: Health & EVP Support for AngloGold Ashanti), and Associate Professor Helen MacDonald (Department of Anthropology, University of Cape Town). Along with the network management team, the steering group members are responsible for: ensuring the network delivers the anticipated outputs and impacts; overseeing the growth and evolution of the Network; and providing governance and financial oversight.

2.3. Outputs, incomes and impacts

A number of activities have been defined to achieve a set of tangible deliverables for the two-year funding period, which extends from August 2019-July 2021. A key activity over this period will entail the organization of networking events, including multi-stakeholder forums; expert working group meetings, sessions at national and international conferences, and community engagement and capacity-developing events. The network also has a number of targeted outputs in terms of building and profiling the network. These include establishing and maintaining an interactive website; building the networks official membership numbers to at least 40 individuals representing organisations across 4 continents and 7 countries on the official development assistance (ODA) list; and developing post-graduate student mentorship programmes across different institutions. The network is also committed to generating at least one article in the popular press, two conference papers entailing new collaborations, as well as props for educational purposes. The network is further required to initiate at least four new post-graduate projects, co-supervised across different research groupings within the network, and to apply for at least one collaborative research grant from a global funding organization such as the Wellcome Trust.

The above-mentioned deliverables are anticipated to give rise to a number of benefits in the short-to-medium term, with key Network outcomes including (i) enhanced trust, engagement and communication between different, often conflicting, sectors and stakeholders; (ii) collaborative and interdisciplinary research initiatives to address mine dust-related health challenges and realise mitigation opportunities; (iii) better-informed mining-affected communities, empowered to actively engage with government and industry in designing and implementing healthcare and impact prevention programmes; and (iv) a regional (and eventually global) hub of activity focussed on knowledge exchange, capacity-

sharing and co-development of integrated solutions, with increased funding potential beyond the initial funding period.

Ultimately these outcomes will assist in the identification and development of integrated and holistic solutions to the health impacts associated with dust emissions from mining activities, thereby contributing to improving the quality of life, health and environment of communities impacted by mine dust. Apart from the direct social benefits, the network is also expected to have indirect economic benefits, by reducing the cost burden of disease which is frequently borne by the public sector health and social security systems, and by also preventing disability and loss of employment opportunities which further entrench poverty and underdevelopment in mining communities. Initial focus will be on ODA countries within Southern Africa, including South Africa, Namibia, Zambia and Mozambique, all of which have significant problems with mine dust related diseases. However, as the network grows through an open membership policy, it will also positively impact the health and environment of mining-intensive developing countries throughout Africa, South America and Asia. Apart from the local, national and regional impacts, by focusing on health effects of mining activities, this network is also aligned with the United Nations Sustainable Development Goal (SDG) 3(Good Health and Well-Being), with links to SDG 11 (Sustainable Cities & Communities), SDG 12 (Responsible Consumption & Production), SFG 15 (Life on Land), SDG 16 (Peace, Justice & Strong Institutions) and SDG 17 (Partnerships for the Goals).

3. Preliminary findings and achievements

3.1. GCRF Mine Dust and Health Network inaugural meeting and open forum.

One of the key activities in the first 6 months of the GCRF Mine Dust and Health Network was the interdisciplinary and multi-sectoral workshop held on 10-11th September 2019 in Cape Town, and attended by 49 delegates from across South Africa and Zambia. In line with the objective of facilitating a shared and common understanding of the inter-related health risks and mitigation opportunities relating to mine dust, workshop delegates identified four priority research areas of key relevance to mine dust and its impacts, namely (i) exposure and health (ii) monitoring and measuring (iii) stakeholder awareness and education and (iv) mitigation and innovation.

Expert presentations and group discussions on the perceptions and understandings of the current challenges, and potential solutions to address such, highlighted the inter-related and complex nature of these issues. The generation of reliable data on the exposure and health effects of mine dust through adequate monitoring and measuring, for instance, was considered to be of key underpinning importance. Although it was recognized that much research has been conducted in the area of occupational health and exposure, there is still inadequate data and information on the sources, toxic levels and health effects of environmental exposure to dust from mining related activities. In particular, the relationship between

the physicochemical properties of dust particles and their health effects was considered to be largely unknown, with regulatory limits and health risk assessments remaining largely concerned with mass concentrations, rather than the inherent properties of the dust itself. Furthermore, it is not known how the different exposures interact, and how exposure is influenced by environmental and social factors such as housing, poverty, access to potable water and the prevalence of infectious diseases such as TB. This is particularly relevant to developing (low to upper middle income) countries, characterized by high levels of informal settlements and artisanal mining activities which exacerbate dust generation and exposure effects, and make regulation and management of such more difficult.

The general consensus amongst workshop delegates was that there is a need for more extensive and long-term surveillance of mining-related dust exposure and health effects in these high risk and vulnerable communities. In this regard, current gravitational sampling methods for monitoring and regulating dust, whilst relatively inexpensive, were considered to be outdated and unsatisfactory. Furthermore, even where installed, the maintenance of air quality measuring stations is considered to be generally poor, and the interpretation of generated data inadequate. Technological advancements in instrumentation and in data management systems create opportunities to establish a network of affordable sensors that can generate extensive and detailed databases and facilitate more reliable source-exposure mapping, particularly in mining communities located in underdeveloped countries. This, in turn, can inform more meaningful regulations and control measures, and potentially address current concerns amongst health practitioners as to whether exisiting regulatory standards are sufficiently adequate to ensure safe environments. Apart from meaningful legislation and regulatory standards, delegates also highlighted the need for a consistent and well enforced regulatory system. It was noted that even where comprehensive legislation is in place, policies and regulations are generally poorly aligned even within, but more particularly across, national governments.

The importance of on-going multi-stakeholder engagement and involvement was highlighted as being essential across all mine-dust related priority areas, particularly in monitoring and measurement, and in the co-development and co-design of policy and mitigation interventions. Such stakeholders should cover all affected and involved communities- including people living in the vicinity of mines and along mineral ore transport routes, miners themselves, policy makers and regulators, civil society organizations, researchers etc.-many of whom may have different, and sometimes conflicting, priorities. Civil society is considered to have an important role to play in holding industry and regulators to account, backed by strong advocacy and an independent judiciary. Civil society organizations can also play a key role in supporting communities to conduct their own research, using tools such as low-cost sensors (through, for example, citizen science approaches). The active involvement of stakeholders in decision and policymaking, however, requires that they have access to relevant knowledge and information. Knowledge sharing and awareness building amongst stakeholders was thus considered essential. Finally, it was recognized that evidence-based policy and practical interventions need to be

based on a consolidated program of research which spans across the disciplines, and takes into account the different perspectives, priorities and issues.

3.2. Partnerships and engagement

Several professionals and organizations with specific interests and expertise in the area of mine dust have been identified, and engaged with, in the initial months of this initiative. This is consistent with the Networks objective to expand the networks sphere of influence and connect with other relevant networks, with initial focus on Southern African countries.

Of particular significance was the engagement with the Extractives and Health Group (EHG) of the Regional Network on Equity in Health in East and Southern Africa (EQUINET), a multi-sectoral advocacy group within region who aim to serve as an equity catalyst to promote and realize shared values of equity and social justice in health in the region. The EGH comprises members from trade unions and NGOs from a number of ODA countries, including South Africa, Malawi, Tanzania, Zambia, Zimbabwe and Botswana. Associate Professors Broadhurst and Adams of the GCRF Mine Dust and Health management team participated in the EQUINET EGH Regional Meeting on 1-2 February 2020 (https://www.equinetafrica.org/content/meetings), and also reviewed the EQUINET discussion paper on public health and mining in East and Southern Africa, which is now in the public domain (https://www.equinetafrica.org/bibliography/64644).

Other key South African groups with common and/or complimentary interests that have been identified as potential collaborators and partners include the Saldanha Bay Clean Air Association and the National Association of Clean Air (NACA). Both these groups are concerned with protecting local environments and communities by preventing anthropogenic air pollution and have extended and multi-sectoral member cohorts. Associate Professor Broadhurst and Dr Johanna von Holdt of the GCRF Mine Dust and Health management team participated in a workshop convened by the Saldanha Bay Clean Air Association. This workshop, which set out to provide information on the air pollution risks in the Saldanha Bay area as well as current legislation and potential monitoring and mitigation opportunities, was attended by local and national government organizations, the general public and industry. The GCRF Mine Dust and Network also provided funding for the annual NACA meeting held in Stellenbosch on 3-4 October 2019 (http://www.naca.org.za/conference.php), and sponsored attendance of two Network management members and four post-graduate students. Associate Professor Jennifer Broadhurst introduced the Network in a conference plenary session at this conference, which was attended by policymakers, practitioners and researchers from several South African organizations.

Contact has also been established with two international research groupings, both with specific expertise and experience on coal dust related health impacts. These include the Minerals Industry Safety & Health Centre at the University of Queensland, Australia, and the interdisciplinary consortium of 10 institutions from UK, Poland, Slovenia, Germany and Spain involved in the EU sponsored project on Reducing Risks from Occupational Exposure to Coal Dust (ROCD). In November 2019, the Network

hosted Ms Nikky LaBranche, an Industry Fellow at the University of Queensland, to discuss mutual interests and potential future collaborative activities. Apart from knowledge-sharing, collaboration with these groups has the potential to contribute to building or enhancing research capacity of research institutions within ODA countries.

4. Concluding Remarks

Apart from causing lung disease and other respiratory conditions in mine workers due to occupational exposure, dust emissions from open pit mines, ore processing and metal extraction plants, ore stockpiles, ore transport containers and mine waste deposits can also significantly influence air quality and the health of the environment and surrounding communities (environmental exposure). This is a particular concern in mining-intensive developing countries within Africa, Asia and South America, where mining and the transport of mined materials frequently occurs in close proximity to human settlements and in fact often serves as a catalyst for the development of both formal and informal human settlements.

The Global Challenges Mine Dust and Health Network is built on the premise that the inter-connected challenges and issues of relevance to mine dust can only be meaningfully addressed through inter-disciplinary research and active collaboration between multiple stakeholders. In contrast to previous discipline-focused thrusts, this network will enable a broad and inclusive range of perspectives to be tapped and consolidated, setting the basis for a holistic understanding of all dimensions of the complexities faced. A shared and common understanding will frame broad policy development, along with the specific components of research priorities in a coherent and congruent manner. Key to driving value, will be the inclusion and appropriate representation of relevant stakeholders, along with the creation of safe spaces for honest conversation to meaningfully address the challenges at hand.

References

Andraos, C., Utembe, W. and Gulumian, M., 2018. Exceedance of environmental exposure limits to crystalline silica in communities surrounding gold mine tailings storage facilities in South Africa. Science of The Total Environment, 619, 504-516.

Csavina, J., Landázuri, A., Wonaschütz, A., Rine, K., Rheinheimer, P., Barbaris, B *et al*., 2011. Metal and metalloid contaminants in atmospheric aerosols from mining operations. Water, Air, & Soil Pollution, 221(1-4),145-157.

Csavina, J., Field, F., Taylor, M.P., Gao, S., Landázu, A., Betterton, E.A. and Sáez, A.E., 2012. Review on the importance of metals and metalloids in atmospheric dust and aerosol from mining operations. Science of the Total Environment, 433, 58–73.

Ehlrich, R., Montogmery, A., Akugizibwe, P. and Gonsalves, G., 2018. Public health implications of changing patterns of recruitment into the South African mining industry, 1973–2012: a database analysis. BMC Public Health, 18,93.

IHRC (International Human Rights Clinic), 2016. The Cost of Gold: Environmental, Health and Human Rights Consequences of Gold Mining in South Africa's West and Central Rand. Harvard Law School.

Knight, D., Ehrlich, R., Fielding, K., Jeffery, H., Grant, A. and Churchyard, G., 2015. Trends in silicosis prevalence and the healthy worker effect among gold miners in South Africa: a prevalence study with follow up of employment status. BMC Public Health, 15,1258.

Kříbek, B., Majer, V., Pašava, J., Kamona, F., Mapani, B., Keder, J. and Ettler, V., 2014. Contamination of soils with dust fallout from the tailings dam at the Rosh Pinah area, Namibia: Regional assessment, dust dispersion modeling and environmental consequences. Journal of Geochemical Exploration, 144, 391-408.

Matzenbacher, C.A., Garcia, A.L.H., dos Santos, M.S., Nicolau, C.C., Premoli S, Corrêa D.S.*et al.*, 2017. DNA damage induced by coal dust, fly and bottom ash from coal combustion evaluated using the micronucleus test and comet assay in vitro. Journal of Hazardous Materials, 324, 781-788.

Patra, A.K., Gautam, S. and Kumar, P., 2016. Emissions and human health impact of particulate matter from surface mining operation—A review. Environmental Technology & Innovation, 5, 233-249.

Petsonk, E.L., Rose, C. and Cohen, R. 2013. Coal mine dust lung disease. New lessons from an old exposure. American Journal of Respiratory and Critical Care Medicine, 187(11), 1178-1185

Utembe, W., Faustman, E.M., Matatiele, P. and Gulumian, M., 2015. Hazards identified and the need for health risk assessment in the South African mining industry. Human & Experimental Toxicology, 34(12), 1212-1221.