MINE DUST
NETWORK

PRESENTATION SUMMARIES

Presentations delivered at the

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PRESENTATIONS

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MINE DUST AS A HUMAN RIGHT'S ISSUE IN THE EMERGING FRAME OF THE INTERNATIONAL RIGHT TO ENVIRONMENT

***Prof Tracy-Lynn Humby**, Professor of Law and Consultant, The University of the Witwatersrand*

The issue of dust in the mining industry needs to be seen as a human rights issue. Furthermore, mine dust must be seen as a community problem and not only an occupational health and safety problem. At an international level, there isn't an internationally recognised right to environment, not like the standard human rights system. However, there is a push at an international level for this recognition. There is lots of research in mapping human rights issues, and specifically in this context, trying to find out substantive content to the human rights to environment.

In 2018, a sixteen-principle framework for human rights to environment was developed. These principles give hooks in which to lay claims against state and mining companies and hold them accountable for dust and air quality issues. For instance, these principles outline procedural norms around human rights, such as prohibiting discrimination, free will and expression, education and public awareness, access to information, public participation, effective remedies and substantive environmental standards that are non-discriminatory. Therefore, there is a lot to be found in these principles that can be used to start framing mine dust as a human right issue.

In 2019, there has been a push to develop human rights norms in particular areas, one of which is the right to clean air. A report released in February 2019 details this, in which it takes the principals and contextualises it for air quality issues. This is not dealing only with mine dust, but also various air quality issues. This report importantly says that fine particulate air pollution is the single largest environmental risk. This is significant as it gives such urgency and credibility to the research. At an international level there is already a statement saying that air pollution is the most significant environmental risk to health worldwide. Furthermore, 90% of the world's population lives in areas where the ambient air pollution is of danger to their health. Another claim in the report is that very few countries have incorporated the WHO guidelines.

This is an exciting time as there is a lot of current research and legal action looking at the issue of mine dust and broader air quality issues.

MINE DUST NETWORK

Living in a haze: Mine dust and health

***Dr Shahieda Adams**, Co-director of the Dust Network and physician at Groote Schuur (UCT), as well as a senior lecturer in Occupational Health Physician*

We know that South Africa's legacy of mining, transport and energy systems, and industrial conglomerates have resulted in environmental exposure problems. Furthermore, we know that 1.6 million people in both formal and informal settlements live in close proximity to mines and these people tend to be historically marginalised and poor. There are studies that show a strong link with living in close proximity to mines and higher level of respiratory diseases such as asthma, pneumonia, emphysema, chronic bronchitis, etc. These lung diseases disproportionally affect young children and elderly.

Metal exposure affects most of our organs from the central nervous system, to hair and eyes, to lungs, to blood and to the peripheral nervous system. This is a significant risk as South Africa has many mineral and metal mines. Well-described organs are the cardio-respiratory effects, as well as carcinogens, and radioactive effects which can be inter-generational (uranium by product of mining of gold).

Silicosis is a disease from silica dust which is a by-product of gold mining in particular. Silica particles enter and accumulate in the lungs, causing excessive scarring and damage to the lungs. It is shown that the longer people work in the mining industry, the more likely they are to develop silicosis. For people who have 30+ years of exposure, there is more than a 45% prevalence of silicosis. Furthermore, in terms of cumulative exposure, we know that the higher the level of exposure, the more silicosis we see. Lastly, silicosis detected at autopsy increased tenfold between 1975 and 2007.

TB in silica exposed workers is an occupational disease due to poor dust control measures. Silica dust does not cause TB, but it pre-disposes and creates an increased risk. Silica reduces immune function of lungs. It is observed that with a 10% increase in production there is roughly a 1% increase in incidence of TB at the population level. Mine workers have between 2 times to 7 times an increased likelihood of contracting TB. This points to the huge impact of mines on population and public health.

Asbestos is a mineral that causes mesothelioma. In the Northern Cape where there was historically lots of asbestos mining, there is 30.5% prevalence of mesothelioma.

These discoveries raise concern over whether the current standards are being protective or not, as standards should protect people and prevent disease, something that is clearly not happening.

There are many challenges that remain with Occupational Health and Mining. Some prominent challenges are the radioactive metals such as uranium in the mine dumps, children & communities living close to mines, the un-known health effects of nano-particles

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which can enter deep into the lungs, informal settlements near mines, and the burgeoning artisanal and small scale mining industry and associated health risks such as from refining using mercury. The Kabwe lead mine is case in point of such an emerging problem. The mine is closed but is causing serious harm as a result of lead poisoning.

The way forward should include the following steps:

- There should be large scale and long term surveillance of health effects in high risk workers and communities.
- We must be vigilant in regards to the informal sector and their risks, such as artisanal mining and vulnerable populations.
- We must be aware of emerging hazards, such as nano-particles.
- We must query if we actually have safe environmental and occupational standards, which is debatable in light of all the trends and health effects that are being seen.
- Finally, we must look at the rehabilitation and long term effects of mining by-products and effects on community health.

Community Engagement: Towards social and epistemic justice

***Prof Helen McDonald**: Anthropology Dep (UCT)*

Anthropologists look at people and try to understand how they make meaning out of things in their life. Furthermore, anthropologists work on the premise that what people *think they do*, *say the do* and *actually do* are often three different things. With mining related topics, and especially mine dust, there is the notion of speaking about communities as defined groups of people. However, communities are not only made up of the marginalised people we often think of. People are different and people are messy. Groups of scientists or CEOs can also be communities. This is a notion that needs to be kept in check.

A prominent understanding of dust by miners is that it brings TB, TB comes from the dust. Miners know TB is from bacteria, however for them the reality is that TB comes from underground dust. This is thus a comment on the socio-political economic environment that they are working in.

There is also talk by the miners about being cannibalised by the mines. They say, "The mines eat us and chuck us out. We are like bubble-gum. They chew us until flavour is gone and then chuck us out." This brings up the notion of thinking about miners as waste, as this is how they see themselves in relation to the mines. Miners seeing themselves as waste is very much connected to dust, and thus another form of thinking through dust.

Dust is difficult to define. An anthropologenic definition is, *matter out of place.* However, as times and technology change, so will our thoughts on and understanding of dust. The scientists define dust in terms of size (PM10) and fall-out, because this is measurable. However, this means that as technology changes, so will the definition. Thus it's important to remember that these things are flexible, and our thinking and understanding needs to incorporate these fluxes.

Another way of thinking about dust is air. A significant thing about air is the sensorial aspects – one smells it before one sees or touches it.

One can also question what is clean instead of *what is dusty. What is clean air? What is a clean space? Instead of: What is a dusty space? What is dusty air?*

There is also the notion of micro-management. Industry manages dust on a large scale, however there is also extensive micro-management of dust by people. Such as keeping the inside of the house clean. People affected by dust are trying to establish the hope of clean places and in doing so, protecting their bodies.

On the political side, Europe is driving the transition towards a greener economy, but a greener economy depends on extensive metal use. This begs the question in terms of greener economy and the subsequent metal mining: *At the cost of whose bodies?*

Thus, the message of this presentation was that we need to think of dust in complicated ways. Historically, dust in the form of incense or perfume is cleansing. Different places, people, moments will have different meanings and understandings of dust.

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Dust management in South Africa: Regulator's perspective

***Olebogeng Matshediso**: The Deputy Director for Atmospheric Policy, Norms and Standards, Department of Environmental Affairs*

People in the regulatory space are expected to protect the rights of the environment and people. In so doing, they pose the question: How to define safe levels? Furthermore, they need to decide whether to use the resources at hand, in determining what safe levels are, or to use them in mitigating dust.

The objective is the protection of one's right to a clean environment (that is currently harmful to heath and well-being).

The policy focus is on a number of issues in South Africa. Firstly, South Africa is a dry country with short rainy seasons. From an environmental justice point of view, we are dealing with land use and economic transformation. Many human settlements are situated in close proximity to dust-generating activities. There are findings that closely link proximity to dust-generating activities, to health problems (respiratory diseases in particular). There is also lots of under-development in South African formal and informal settlements in terms of infrastructure, which exacerbates dust exposure and generation. A major issue in the South African mining industry is the legacy of old & abandoned mines and their subsequent impact. Furthermore, government is supposed to bear the costs of rehabilitation. How do we prioritise rehabilitation from the little government resources we have? Finally, industrialisation, agriculture, construction activities and deforestation - the question is how do we deal with these issues and ensure that environmental legislation influences sustainable development.

The main focus of current legislation has been to reduce nuisance dust and develop best practice measures for the control of dust. However, there are many issues that cannot be controlled within the legislations and the South African legislation is very fragmented. All the different departments and regulators to need to collaborate to produce a succinct and singular legislation, that takes into account the radioactivity of the dust, as well as chemical composition. These are the issues that the legislation is currently trying to strategically deal with and to get other bodies, as well as multi-stakeholder corporations, to take responsibility.

In 2013 the first set of regulations were implemented. These intended to empower Air Quality Officers to issue notices, record and respond to complaints, and conduct monitoring and evaluation of interventions that were put in place. On the industry and consultancy side – the idea was that regulations would empower those in the monitoring sphere to establish acceptable dust deposition levels. However, it is worth asking if there can really be dust levels that can confidently be said to be safe. If not, how do we move forward from a regulation point of view? Furthermore, regulators should prescribe dust measurement methods, starting with the traditional bucket monitoring. Now is not the time to think of other methods that are not limited to gravitational sampling, and to try and understand the elemental composition of dust and the associated impacts so that regulations are really all issues and not just dust levels.

The first regulations have been implemented since 2013. They are being reviewed and weaknesses, that have been identified, are currently in revision.

Dust management strategy will focus on each area and identify roles and responsibilities for government. Furthermore, alignment is needed with environmental and occupation health. Air monitoring practise, recognized nuisances and management measures, and cost rehabilitation.

Government is in need of help from the Dust Network for bettering the quality of legislation and regulation. Evidence-based policy interventions need research. Such research includes health assessment of dust, advancement of management techniques, and prevention and mitigation measures.

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INSIGHT INTO THE PHYSICOCHEMICAL CHARACTERISTICS OF INHALABLE DUST IN RELATION TO RESPIRATORY STRESS

***CK Kamanzi,** UCT PhD student, UCT*

It is very important to understand the physicochemical properties of dust to holistically understand risk. The current metric for measurement of exposure is mass or volume concentration of particulates in the air. This is size dependent in which particulate matter is defined as being above 10 microns, under 10 microns or under 2.5 microns. This metric makes the assumption that particles are equally as toxic and that it doesn't matter where the dust comes from, nor does it take into account the inherent properties of the dust itself.

What is of importance is the *exposure, dose and effect relationship*. *Exposure* is defined by the mass concentration, the *effect* is defined by the oxidative stress and *dose* is defined by retention, which is size dependent. Importantly, the effect is not respiratory disease as this is the final stage of oxidative stress. Oxidative stress leads to inflammation, from which aggressive inflammation of the lung leads to a respiratory disease. These reactions occur in the alveolar region of the lung, which is the deep part of the lung where the air-blood barrier exists.

Dose or retention is the difference between the particles deposited in lung and those removed by the lungs clearance mechanism, and is size dependent. Anything that is between 10 and 100 microns will not be deposited in the lung. Furthermore, breathing through nose or mouth also determines deposition of particles in the lung. Particles under 10 microns (PM10) have high probability of being deposited. The clearance mechanism prevalent in alveolar region is macrophages, which digest particles or remove them so they are not free for reactions.

Currently, it is known that size is important, however it is necessary to determine how the other characteristics of particles effect the removal process. Bio-persistence is the term used as a surrogate for retention, which looks at chemical properties or biological durability of the dust and the physical and mechanical processes that remove it. These physical processes that remove dust from the lung can be affected by the individual characteristics of the particles. This can be mediated by how bio-accessible these particles are in your lung.

Oxidative stress is the effect of dust in the alveolar region and is dependent on how particles react with cells and lung fluid, which results in the formation of a free radical or reactive oxygen species (ROS). These free radicals or ROSs, trigger an oxidative stress response in the body, which in turn triggers inflammatory responses. This results in contraction of disease. The different physicochemical properties affect the production of free radicals and start the oxidative stress process. Such properties include the encapsulation of reactive phases, grain size, crystal morphology, trace elements and mineralogy.

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To illustrate the importance of these physicochemical we look at pyrite (an iron sulphide mineral) and how bio-accessible the iron is. Transition metals have the affinity to produce these reactive oxygen species. They produce two ROS's, namely hydrogen peroxide and hydroxyl radical (very reactive). Firstly, a 10 micron particle has a higher probability of being deposited than a 100 micron particle. Smaller particles also have higher surface area, so these favour the progression of the reaction. Secondly, if a pyrite grain is encapsulated in an inert substance there will be no surface area for reaction, however if there is an exposed surface area for reaction, then the generation of ROS can occur. Thirdly, the configuration of atoms or crystal lattice determines how amenable the metal is to being dissociated by different processes and whether it will allow for a reaction with the lung fluids. Fourthly, the association of different minerals can change the chemistry of the system i.e. if pyrite is combined with a carbonate mineral then the carbonate will buffer the solution. If combined with an insoluble material then it will be highly acidic and a reaction will take place.

These illustrate how the effects of exposure to dust depends on inherent properties of the dust. Bio-accessibility plays an important role in how contaminants react in an exposed environment. Thus, future metrics for risk definitions should incorporate how harmful dust can be upon exposure due to inherent properties of dust itself.

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REGULATORY MODELLING OF MINE DUST IN SOUTH AFRICA

***Roelof Burger –** North West University, Senior Lecturer, Unit for Environmental Science and Management, and part of the Climatology Research Group*

Our biases in understanding problems affect how they are interpreted by the regulator. In South Africa, the dominant source sector of air related health impacts in South Africa is Eskom (bio-mass burning and dust). Eskom's emissions are easy to understand and predict as they have been more extensively characterised and well reflected in international emission estimates. There is consequently better regulation for certain industries, and is dis-proportional to the size of the risk or the impact. Furthermore, a recent study in a residential area with no industry around for a 50km radius - the levels of air quality exceeded standards for 50% of the time. This translated into human activity based emissions. This is something that is not conventionally considered, and is often associated with industry due to our biases and pre-conceptions.

This speaks to the importance of source-apportionment. There is a trans-disciplinary research group looking at mine dust, consisting of post-graduate students in chemistry, geography, law, geology, urban planning, education and the social-sciences. There are two projects underway that look at source apportionment, one in the Vaal and one in Wedela. The socio-economic factors and drive are very important in these areas. Often the indoor conditions are worse than ambient conditions, which should make one pause and reflect on where does one draw the line with mining and mine dust. Dust makes its way into an indoor environment, both physically and through poverty. Furthermore, in Wedela, during August and September, the ambient concentrations of dust from tailings are significantly higher.

Receptor based modelling as apposed to dispersion modelling is perhaps the most direct way to determine the important sources contributing to air quality at a point (source apportionment). Dust plays a surprisingly important role in air quality, especially in the light of our current focus on other sources. Dust in coarse fraction (>2.5 microns) is especially significant, while in the fine (<2.5 microns) it is less so but still significant. Domestic burning of fuels is also highly significant, and is related to socio-economic conditions inside the house hold. The study's findings show the immense complexity of the issue of air quality. It is hard for regulators and for community members, who experience the effects of air quality.

Another study is looking at air quality management plans (AQMPs). This is looking at how mine dust is being dealt with in the regulatory environment. Also whether mine dust is acknowledged as important, if it is incorporated into emission inventories, and is there a proposal of mitigation and monitoring solutions. Mine dust is certainly acknowledged as important, but that is where it seemingly stops. There is dramatic variability in quality and depth of these AQMPs and the assessments.

For emission estimates the factors that should be considered for monitoring and mitigation efforts are site specific factors (such as particle size distribution, bulk density, moisture content and erodible area). Monitoring is also a current challenge, illustrated by the fact that moving a monitoring station by 3km can change whether it assesses dust to be a problem or not.

The current state is that mine dust is being considered to a varying degree. Furthermore, source apportionment has confirmed that mine dust is an important source in terms of health impacts. However, there no clear guidelines in dispersion modelling, nor are there sufficient mitigation targets. It is also very complex to model mitigation efforts and finally, emission estimates perhaps present the biggest uncertainty.

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Atmospheric Dust Emissions from Surface Mining: Prioritising Monitoring Strategies for Compliance and Management

***Matthew Ojelede –** Digby Wells Environmental Consultancy - Air quality specialist*

When we look at monitoring we need to ask the question - what is the emphasis? Is it one of compliance or is to obtain information that will help us make management decisions, to ensure such emissions are controlled at source, and exposure is reduced in nearby communities?

The Witwatersrand has a number of mega-dumps. Windblown dust from tailings is confirmed as a constant to ambient air pollution. Rates of erosion from unprotected tailings storage facilities in South Africa are large, with losses from unprotected slopes of gold tailings of more than 500 t/hectare/year are quite common. Monitoring of wind generated fallout dust has taken place since 1985 around coal and gold mine tailings, however investigations into the respirable components of mines tailing dust emissions, have been few.

Dust pollution can be incredibly evident, for example, the sky being hazy and dust deposited on cars, in school rooms and on the children's desks. In a few minutes dust levels can peak in the environment. The SA Air Quality Limit for PM10 24 hour average is 75 $\mu g/m^3$. In the dusty months this is exceeded almost every day, and has been as high as 2160 $\mu g/m^3$.

If anyone produces dust that may exceed the dust fall standard then according to South African Dust Control Regulations, they must "*within a year after the publication of these regulations, submit a dust monitoring report to the air quality officer*". Furthermore, if they have exceeded the dust fall standard, they must "*within three months after submission of the dust monitoring report, develop a dust management plan."*

Multiple dust fall samplers provide a broad spatial coverage and measure mainly local sources (<5km) such as TSFs. It is inexpensive per unit installation and per network, and easy to interpret the data. It aids source apportionment, and provides useful management information to determine if dust control is effective. Fine particulate samplers however only show information for one place per installation, and measures both local and distant sources (>100km) thus non-specific to mining TSF sources. These are expensive per unit installation and the data is difficult to interpret by non-experts. Furthermore, they give very little information for the management of dust.

At a typical receptor site in Soweto, downwind from a TSF there is 1150 hours of high wind per year, and for 845 of these hours, the wind blows from a TSF towards the residents. This equates to 106 eight-hour work shifts. 12 work shifts for August, 15 shifts for September, and 18 for October. This is above acceptable occupational health guidelines

Working towards sustainable ambient air quality management from pit to port in KwaZulu Natal - Developing framework for air quality management for the ports.

***Litha Dalindyebo** – Transnet – Senior manager for risk department at Transnet port terminals, and does resreach for air quality for Transnet – PhD Canidtate UKZN*

Transnet port terminals are the gate way for imports and exports, which includes the ore that is mined. Thus, as much as there needs to be focus on the mines, there must be focus on the ports where the ore goes in and out of the country. Thus, a framework is needed for air quality management in ports.

The study, due to size of the ports, focusses on only bulk terminals and break-bulk terminals. Namely Port of Richards Bay, both bulk and break bulk, and Durban, break-bulk. The minerals and metals that were focussed on at Port of Richards Bay were chrome, ferrochrome and magnetite. While at the port of Durban manganese was focussed on.

At Richards Bay the bulk sector runs at 21 million tonnes per annum, while the break-bulk runs at 8 million tonnes per annum. For Durban, break-bulk, runs at 1.2 million tonnes per annum of manganese. Manganese was the fastest growing commodity exported out of the country last year, and there is currently a high demand.

Thus, this study of creating a framework for managing air quality that looks at cargo and port equipment, is important for Transnet port terminals. This is done through four papers which focus on four essential factors.

Firstly compliance.
Secondly, developing an emissions inventory.
Thirdly, develop a dispersion model. Finally, to perform an integrated life cycle assessment, using Simapro.

For compliance, a compliance analysis tool was used, which factored in the air quality act, dust regulations, and the carbon tax act. Furthermore, the climate change bill was looked at, and was subject of a gap analysis for future planning.

The whole process of handling ore was needing to be considered. Thus it started with the compliance from where the ore enters the port at the tipplers. Next, the conveyor belt system, of which there is 30km of, was looked at for impact. The conveyors have a dust extraction system as a control. Finally, the stock pile is assessed and the equipment that the port uses.

The emission factor came from the standard. Factors such as the type of product, the length and breadth of the road, the stock pile capacity, mitigation such as sprinklers were factored into equations for wind erosion, equipment and conveyors.

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