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THE IMPACT OF MINING INDUCED URBANIZATION: A CASE STUDY OF KATHU IN SOUTH AFRICA

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ABSTRACT

Rapidity in urbanization has continued in the past decade despite the realisation that resources are finite. Commerce, migration, employment, industry configuration and population increases are factors that contribute significantly to the urbanization phenomenon. With respect to the contributions of commerce, mining activities have led to the advancement and regression of cities. An abundance of literature exists on the negative effects of urbanization and mining on the environment. The main reason for the research that produced this initial findings was to determine how urbanization, when induced by mining, impacts on the environment and how to ensure future sustainable urbanization. The research was done qualitatively through interviews of knowledgeable individuals within the relevant industries within the mining town of Kathu, in the Northern Cape of South Africa. The research found that centralization of employment, resources and trade lead to urbanization, which is primary driven by the mining industry. In addition, it was observed that mining as a factor that accelerates urbanization, also impact negatively on the environment. Thus, there is a need for a rethink about mining induced urbanisation so as to reduce pollution and other adverse event of secondary activities that support the primary industry of mining.

Key words: Environment, Mining, Urbanization, South Africa

1. INTRODUCTION

A lot of research has shown that human activities have negative effects on the environment as these effects drive global warming. Urbanization can be seen as the gathering of people and market activities due to a number of influences. One of the activities that forces migration of people and labour is that of mining (Crush, Williams and Peberdy, 2005). As time passes, urbanization rates have been on the increase and so does the amount of damage done to the environment (Alam, 2010). Mining drives growth, expansion and urbanization either in a small town or in a big city (Bryceson and Mackinnon, 2012).

However, previous research has suggested that the relationship between urbanization, energy use and emissions is complex (Poumanyvong and Kaneko, 2010).

Thus the effects of a phenomenon such as urbanization cannot be kept to a circumstance. This particular paper attempts to highlight the effects of mining induced urbanization on the environment. The research is important as the primary data collected shows how individuals experience urbanization and the effects thereof in a South African mining town. The literature shows cases around the world where similar urbanisation trend have occurred. The paper begins with a comparative analysis of urbanisation and mining. It then went on to use a specific mining town as a case example of the environmental impact of mining induced urbanization in South. The creation of a sustainable development initiative in the face of rising urbanisation was highlighted before a succinct explanation of the research methodology was provided. The findings of the study and their implications constitute the relative contributions of the exploratory study. The conclusions thus emphasised the need for "mindfulness" while encouraging mining activities that engender increased urbanisation in South Africa.

1.1 Research Rationale

Small towns serving as hosts to large mines face environmental impact challenges as mining induced urbanization affects the environment and ecosystems of host towns negatively (Alam, 2010). Although international studies have mentioned the effects of urbanization and mining, this is not the case in the Northern Cape Province of South Africa. To bridge this specific local knowledge gap, three basic questions were formulated and used for primary data collection. The questions include:

- How does mining accelerate urbanization in small towns?
- What is the effect of mining on the environment in a small town?
- What can be done to ensure sustainable urbanization in mining towns?

The study aims to determine how individuals, who actively work in the mining and construction industries and living in the area of the study, experiences urbanization. Thus, the study is an attempt to determine the main factors that cause and influence urbanization at the instance of an expanding mining industry. The determination of these causes would thus be used to argue for alternative approach to urbanisation so that environmental issues can be tackled at the planning phases of development.

2. MINING, URBANIZATION AND THE ENVIRONMENT

Urbanization is a large-scale transition and centralization process of resources, industries and population in a certain area. The notable characteristic of urbanization is that it will break the traditional agriculture oriented structure and results in the concentration of population and industry and the expansion of urban land (Biao, Chuang-lin and Mao-sheng, 2006). One of the main pull factors for centralization of labour and industries is mining, as can be seen in historical examples.

One such example is Sierra Leone, an African country. When discussing diamond mining, urbanization and social transformation in Sierra Leone, Maconachie (2012) describes an example of urban growth in the town of Koidu, an area that used to be entirely devoted to farming.

In 1928, before the discovery of diamonds, Koidu was not even a town. It was a small settlement that had six huts. However, Sierra Leone experienced a large diamond rush in the early 1950s that resulted in a vast influx of migrants from within the country and the larger West Africa region. The migrants converge on areas around Koidu, the place where diamonds had been discovered. This resulted in many people giving up their traditional work and moving into mining as a full-time occupation. By 1963, the town's population had grown to 14,309 people; a significant population growth that would have been unimaginable without the mining of diamonds. Koidu's growth was very rapid and the town became the main market centre for the area.

In similar context, many historians see the mineral revolution as a turning point in the nineteenth century South Africa. It sparked industrialization and gave rise to cities such as Johannesburg and Kimberley (Visser, 2012). The first Witwatersrand gold fields were opened in 1886. Harrison and Zack (2012) describes the period of 1886-1948 as "the rise of gold and the rise of Johannesburg". After gold was discovered, mining claims were pegged out on privately owned farms along the reef, with mining camps spreading out north and south of the diggings. Johannesburg, as a formal settlement, was however proclaimed on a triangular piece of leftover state-owned land, north of the mining belt. The settlement was not considered to be permanent and it was laid out crudely on a tight grid with small blocks (Beavon, 2004 cited in Harrison and Zack, 2012: 554). Johannesburg had an unusual location and only existed because of a gold reef and the mining camp soon burst into a bustling town with banks, shops, hotels and boarding houses, a stock exchange, and the inevitable saloons and brothels. It took a mere 10 years for Johannesburg to turn into the largest urban centre in Africa south of the equator, and its population of 102,000 exceeded that of Cape Town (Harrison and Zack, 2012). A census conducted by Statistics South Africa (2011), the city of Johannesburg, an area that was once just farmland had a population of 4,434,827 people at the time.

As these examples show, mines - just like urbanization - start in small unpopulated and / or mostly rural areas. As these new and developing mines recruit vast amounts of employees required to maintain their operations in agricultural areas with a small local population and limited skilled workers, they are forced to recruit employees from different towns within a province. Whether mines pay for it or whether it is at the hand of the employees, these people need to be accommodated, in most cases, with their families. As an illustration, in 2012 alone a single mining firm employed a total of 8213 people at its mine in Kathu. If 8000 people who had been employed and just had one person living with them, you have 16000 people moving to such a small town in one year. Only 8000 of these people are employed at the mine, meaning that the rest will have to live and work in other markets within the town. This leaves a huge gap in the market for the entrepreneur and a demand for products and services of a general nature. This is an illustration of urbanisation in a mining town.

The more the mine grows, the more the town has to grow to accommodate the people. Urbanization in a mining town starts with housing for mining workers and their families within the town.

But as demand grows, certain specialized needs come to light and businesses starts opening, schools get built etc. Large shopping centres are usually one of the first signs of urbanization and growth within a town.

The most intensive interactions between people and the environment take place in cities and surrounding areas (He et al., 2007). Megacities are seen as high dense metropolises with a minimum population of 10 million inhabitants (UNEP, 2011). In 1992, the number of these megacities was 10, in 2010 there were 21, a 110% increase, adding on average one megacity every two years. Fifteen of the world's 21 megacities are found in developing countries. The largest megacity in the world today is Tokyo which has nearly 37 million people, more than Canada's total population. With these large and dense metropolises come the associated environmental impacts of urban life. Such very dense population structures means that are people living in close proximity to each other. With this comes issues of sanitation, waste management, air quality, pollution and other concerns for residents and the environment alike (UNEP, 2011). In particular, China has the biggest human population in the world (Wu and Tan, 2012), by 2050 an estimated 77% of that population will be living in urban areas (UNEP 2011). Urban areas that form cities thus affect climate change (Roy, 2008):

- With a high level of energy consumption, concentration of economic activities and burning of fossil fuels.
- With a higher concentration of resources and expertise.
- with a higher population concentration of man-made infrastructure to protect people against elements, which include sea-level rise, tropical cyclones, flooding and landslides, water crisis, and heat and cold.

As Roy (2009) observed, cities contribute to climate change as the global mean temperature increased by 0.4°C between 1992 and 2010 (UN, 2011). A distinctive feature of compact and dense cities is the urban heat island (UHI) effect. Sealed surfaces, such as roads, buildings, and other constructed surface areas, absorb and retain solar irradiation. The displacement of trees reduces natural cooling effects of shading, among other elements. As a consequence, the UHI effect increases the city air temperature by 1–3◦ C relative to the surrounding area (Madlener and Sunak, 2010).

The extremely high rates at which Global human population and urban development are increasing causes tremendous stress on local, regional, and global air and water quality (Duh, Shanda, Chang and George.2008). The concentration of carbon dioxide (CO2) in the Earth's atmosphere has been measured at Mauna Loa, Hawaii since 1958 and at five other stations subsequently. It shows a steady mean increase from 357 ppmv (parts per million by volume) in 1992 to 389 ppmv in 2011. Seasonal variations of about 5 ppmv each year correspond to seasonal changes in uptake of CO2 by the world's land vegetation, influenced by the greater vegetation extent and mass in the Northern hemisphere.

A case study done by Wu and Tan (2011) to determine the effects of urbanization on water show that water scarcity is one of the most difficult challenges facing China. It has even evolved to a common constraint to urban development in relatively well-urbanized eastern coastal China.

The case study presents the urbanization process, water shortage and water environment changes in the last decades, and discusses the interaction of urbanization and water utilization. The results suggest that rapid urbanization has brought about increased growth in urban water usage, especially domestic water consumption that give rise to tension in urban supply and demand. Another example of damage done by urbanization related to water can be seen in the Mesopotamian Marshlands, which is the largest wetland ecosystem in the Middle East (Partow 2001 in UNEP, 2011). Construction of numerous dams, water diversions and hydropower facilities on the Tigris and Euphrates Rivers over the past century and the deliberate draining of the marshes by the Iraqi regime in the early 1990s had almost destroyed the wetlands by 2000 (Aoki and Kugaprasatham, 2009).

Various effects and mechanisms of the urbanization process show substantial impacts, not only on air and water quality, but also on urban structures and energy consumption. The impact mining has on the environment can be seen in a number of examples. Mining acting as catalyst for the urbanization and development of Johannesburg and the Witwatersrand area (as discussed previously) was, not too long ago, frequently in the headlines due to the water contamination caused by the large amount of mines in the area as reported in the Rapport (Eybers, 2010). Apart from water contamination, other factors exist. In China, environmental problems caused by coal mining become increasingly serious, threatening the ecological safety in the mining areas (Shi et al., 2010). For this reason, environmental pollution poses an important social problem. After a case study in the Hancheng mine area, Shaanxi Province, China, results show that residents in the areas think that air pollution is the most serious environmental pollution; followed by noise pollution, environmental sanitation and water pollution. According to the public perception, environmental pollution in mining areas mainly result from coal processing (washing, screening, and cooking) and poor law enforcement (Shi and He, 2012).

Environmental effects do not just come to light when mines are active; a case study of the long abandoned Rio Tinto mines in Spain was conducted to determine the contribution of mine wastes to atmospheric metal deposition in the surrounding area. The results show that the mine waste factor is evident in the sampled sites exposed to dust-bearing winds downwind of the mining area. This suggests that mine wastes are the source of heavy metal particles, which lead to a typical suite of hazardous trace elements with potentially adverse environmental effects to surrounding soils and plants, and the vicinity of a village located in the direction of the prevailing winds. Particle grain segregation was observed during the transport of this metal dust from the mine wastes, registering a difference of between 3 and 8 g/m2 (gram per meter squared) of particle matter deposited along the prevailing wind direction. This segregation may occur during wind events resulting in suspension of coarse particles from the mine wastes.

Once the coarse particles are deposited (within meters of the mine waste deposits), the fine fraction of this metal dust may be transported to long distances by winds causing a direct impact on the population of residents and on the agricultural crops in the surrounding areas.

Besides this direct impact, the chemical profile of the sampling locations outside the prevailing wind direction also contains the same toxic elements as the areas inside the prevailing wind line. This implies that the metal dust derived from the mine waste deposits has a certain influence in the entire mining district. In ancient mining districts with long histories of mining and metallurgical activity, mine wastes represent one of the main sources of pollution to soils, water and air (Castillo et al., 2013). To be brief, the literature has demonstrated that expansion in intensive industrial and agricultural activities and rapid urbanization affect environment adversely (Alam, 2010).

3. SUSTAINABLE DEVELOPMENT AND URBANIZATION

Sustainable urbanization has become an important aspect in promoting sustainable development (Shen, Peng, Zhang and Wu, 2011). Sustainable urbanization is recognized as the way to address the problems caused and faced by cities. However, sustainable urbanization practice can be achieved if sustainability goals are defined clearly (Shen, Ochoa, Zhang and Yi, 2012). The challenge of addressing climate change in urban areas is clearly one to which architects and planners can contribute significantly. For example, they can look at developing settlements and constructing houses that are more energy and water efficient while also looking at ways to reduce risk to human and environmental health (Mills, 2006).

Due to differences in city structures, economic development and administrative structures, urban policy implications and management of urbanization have to be adapted to the different urban conditions and situations. In developed countries, urban energy planning concerns different city levels. Prior challenges address energy efficiency measures and the increase of the share of renewable energy sources. Major challenges are the formalization of the informal economy, the development of basic infrastructure, and the integration of energy planning in urbanization management (Madlener and Sunak, 2010).

Planning for sustainable urbanization, with support from interactive modelling, has a useful role to play in planning and promoting future urban and regional sustainability (Roy, 2009). As urban growth and rash advancing rural-urban migration are commonplace throughout the world. According to Wu and Tan (2011), a more practical urban scale structure should be scientifically planned to guide the future urbanization development through a number of initiatives. Such initiative should:

- Be based on the local water resources and environmental conditions, and population. As water shortage and water environment problem is much more serious in larger cities with bigger urban population and larger industry economy, the number of megacities and the population size of each megacity of the province should be strictly controlled; while medium-sized cities and small towns must be supported to develop in particular.

- Reduce industrial water use, while the government should guide each city to adjust and upgrade local industrial structure.
- Improve water management to regulate water consumption.

Furthermore, Newman (2006) contends that a sustainability assessment approach to cities takes environmental impact seriously, and gives it mainstream consideration while simultaneously asserting the value of social and economic progress. Accordingly, Newman (2006) opine that the positive aspects of cities can be merged into a net benefit approach, where the enduring value of environmental improvement, social gain and economic enhancement can be seen as a joint legacy for the future.

4. RESEARCH METHOD

The qualitative research method was utilized for this study. The method focuses on phenomena that occur in natural settings by studying and capturing the complexity of the phenomena (Leedy and Ormrod, 2013). This method was chosen specifically as it allows the researcher to discover problems that exist within the phenomenon. The research has been designed as a Case study of a mining town in the Northern Cape Province of South Africa in the form of interviews with a standard questionnaire with a phenomenological approach. Interviews were conducted with a sample size of five individuals, who have had direct experience and exposure to the phenomenon. According to Creswell (2007), the phenomenological approach uses interviews to collect the primary data for research projects. The primary data were obtained by identifying individuals active within the construction or mining industry and that works and lives in Kathu in the Northern Cape Province of South Africa. After identification, they were all contacted via telephone and informed on the research. Willing candidates were then presented with the research protocol and the research questions under each theme. Twenty two individuals were identified and were asked to take part in the research.

The start of the interview has a cover page to introduce the researcher and the research to the interviewee. Then there is a section of general information on the interviewee and the organization that he/she works for. The last section is an open ended questionnaire with three themes and twelve related questions. The first question in the questionnaire determines whether the interviewee is aware of the phenomenon, to ensure only knowledgeable candidates complete the interview and to ensure the quality of the data collected. Remaining questions were aimed at getting answers to the original research questions arising from reviewing the related literature.

The research sample for the primary data comprises of twenty two individuals active in the construction industry within Kathu. They include: contracts managers of construction firms, quantity surveyors, supply managers and subcontractors. In order to gain knowledge from the other side of research problem, six employees of the Sishen mine in Kathu were selected.

Their positions at the mine includes: Environmental managers for water, pollution and two health and safety officers. The other 16 were individuals working in the construction industry in Kathu.

Two of the people employed by the mine, declined the request to be interviewed and the other four agreed, but also declined once the questions were put before them. They state that it is against the mine's policies for them to answer the questions contained in the questionnaires. Out of the 16 construction employees, only five agreed to partake in the research.

Table 1: The demographics of participants / interviewees

Number	Age	Years in industry	Highest level of education	Job Title	Aware of mining/construction's impact on environment
1	56	31	Bachelor's Degree	Director	Yes
2	29	8	Bachelor's Degree	Owner	Yes
3	27	6	National Diploma	Contracts manager	Yes
4	54	25	Certificate	Owner	Yes
5	30	9	National Diploma	Safety officer	Yes

5. RESULTS AND DISCUSSION

This section presents the perceptions of the interviewees relative to the research problem thematically.

5.1 Theme 1: Urbanization and development

In general, the interviewees suggest that urbanization starts when an opportunity for employment that leads to migration of workers exists. When workers migrate to a certain place in numbers, needs for services, products and housing arises. Thus basic human needs and the need for employment contribute to urbanization. In the case of Kathu, the town in the Northern Cape of South Africa, mining is the industry that provides this employment and all interviewees agreed that the existence of the mine increases urbanization. Through on site visit, the principal researcher observed large scale development and housing projects actively taking place in Kathu in the form of small three bedroom for mining employees. Contracting firms, one of which the researcher worked for in Kathu, receive contracts to construct up to thirty houses a month. This proves a direct link between the mines in Kathu and urbanization.

5.2 Theme 2: Factors impacting the environment

All of the interviewees unanimously agreed that urbanization impacts negatively on the environment as green / or undisturbed areas are used and developed for housing, shopping centres and infrastructure purposes. Participant 2 made a comment that rural farming areas have more resources and less people.

More of the surface area of the earth is left untouched, the air and water in such areas are generally cleaner, but in urbanized cities, such as Kathu, there are more people in a smaller space and more resources are used to produce wastes that impact negatively on the eco-system. The general consensus among the interviewees was that the effects mines have on the environment are largely negative. They perceive that mines use land previously used as agricultural land and damages it through the mining activities. Mines have a closure liability that forces mining companies to rehabilitate the earth where mining has taken place when mining stops, but interviewee 4 states that "the land is unusable after mining has taken place, even after rehabilitation".

The matter of whether the impact of mining and development on a mining town is monitored is one that produced mixed answers. The general opinion is that the measures are put in place. However, one interviewee differed in his response to the question when he says "according to me, nothing, how the methods are enforced and controlled is not known."

When asked about pollution, all the participants responded that pollution is visible and present in Kathu. The biggest problem, air pollution, is due to smoke from explosions when the mine detonates explosives within rock beds to break it and reach the iron ore. These explosions also cause large amounts of red dust to be blown into the air and spread throughout the town by the strong winds in the Northern Cape. This red dust (red due to the presence of iron ore) is said to damage vegetation to a large extend according to interviewee no 1. The participants also perceive that pollution is on the increase in the town and the effects are becoming more visible.

Measures to address these problems and prevent them, are put in place by the mine and the local municipality, according to some of the interviewees. Most of them, however, say these methods lack efficiency or that they are not enforced. As an illustration, Figure 1, which was a picture taken during the field work, shows that soil / sand on the side of a car is mixed with the red iron ore. This is found on roads, vegetation, buildings and in the air in Kathu. This sand is loosened by explosions and carried throughout the town by winds. The picture was taken by the researcher in Kathu as part of his observation of the town.

Figure 1: Soil that is mixed with Iron Ore in Kathu

To buttress the pollution related points, the pictures in Figure 2 and 3 were taken while the principal investigator was working on a construction site in the town of Kathu. In Figure 2 the smoke from a blast was observe to be instrumental to air and noise pollution in Kathu. If looked closely at Figure 3, a darker smoke is visibly coming from behind the mine's deposit dumps. This, along with the heavy red sand is what people living in the surrounding towns see and links with pollution.

Figure 2: Smoke that emanates from a mining blast in Kathu

Figure 3: Smoke from a mine's deposit dump in Kathu

5.3 Theme 3: Sustainable development

In this theme, responses were fairly uniform. Answers to the first question reveal that all the respondents concurred that the mining company involved should be held responsible for the environmental impact of urbanization, if the urbanization is induced by a particular mine.

With the exception of one of the participants, everyone was of the opinion that enough is not being done to ensure sustainable development within the context of mining induced urbanization. This is supported by participant 3 who state that "the mine's aim is to continuously operate at maximum production for decades to come, I feel that this will last for the next 20 years at most, leaving the rapid expanding town with an oversupply of housing and a lack of employment."

Recommendations made for sustainable development include more environmentally friendly mining activities and controlled mining pace, which will lead to controlled development and urbanization through the use of alternative methods and materials for construction. In addition, concerted efforts should be expended to determine and monitor the environmental impact of mining activities and corresponding development. The findings of such undertaking should also be made public so that future developments and activities would know how to address similar problems.

6. CONCLUTION

It is clear from the interviews that knowledgeable individuals based in Kathu have observed a negative impact on the environment due to mining induced urbanization. It is evident from the related literature that urbanization is taking place rapidly and the larger portion of the population of the world population is already living in urban areas. Both the literature and the interviews reveal that urbanization in most cases takes place when a large supply of employment exists in an area because the attractive jobs lead to the migration of workers and families. Industries are large contributors to the existence of such employment, as they employ people on a large scale. One of the main industries in South Africa that contribute to the existence and expansion of towns and metropolitan cities is mining. As such the mining sector has a relationship with the pace of urbanization in South Africa, especially in the case of Kathu.

The study has answered the three postulated research questions through the reviewed literature and the interviews. Although exploratory at this stage, the findings of the study tend towards the assumption that employment and the movement of people always accelerated mining induced urbanisation. Through the use of direct observation and the transcribed interviews, it can equally be noted that mining activities impact on the environment negatively in the form of noise, air and soil pollution. Therefore, alternative methods of construction in a mining town as well as controlled mining activities should be promoted, not only in Kathu, but also in all small mining towns that are rapidly urbanising.

While the role of the mining sector in an economy in terms of job and wealth creation cannot be disputed, poorly controlled mining activities could also lead to unintended consequences in terms of human and environmental cost. A balance between the determining factors of urbanization and their effects is needed, especially within the context of the town that formed the case example for this study. For the specific town in question, more research is required to determine the exact extent to mines have accelerated urbanization and what can be done to limit and monitor it.

While solutions pertaining to alternative methods and materials for construction and mining are laudable, specific empirical studies that target the various impact of mining on the environment should form a basis for reliable interventions.

As mention earlier in this paper, the mine workers declined to participate in this study for a range of reasons, which points toward job security.

In this regard, a future study should get the support of a specific mine so as to determine the extent and type of impact the mine and its surrounding towns have on the environment. Such an approach would bring about specific solutions to the pollutions that are now pervading the environment in Kathu, for example.

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