Imperial College London
Consultants

Environmental Impacts of Mined Diamonds

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This report is the independent opinion of the author

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Executive Summary

Mineral resource exploitation causes irreversible damage to the natural environment shown through negative impacts on water resources, air quality, wildlife, soil quality, and climate change consideration. Mining affects water quality and availability of water resources within the project area. There is potential for acid mine drainage and contaminant leaching. Largest sources of air pollutions are from particulate matter transported by the wind and gas emissions from combustion of fuels in stationary and mobile sources. Mining affects the environment and associated biota through the removal of vegetation and topsoil, the displacement of fauna, the release of pollutants, and the generation of noise. Mining can contaminate soils over a large area. Agricultural activities near a mining project may be particularly affected. Diamond exploration and mining use two forms of energy: electricity and hydrocarbons (diesel, marine gas, oil and petrol). A by-product of both electricity and hydrocarbon energy is the release of carbon emissions into the air, such as CO2 (a naturally occurring gas). Carbon emissions are considered to be a major factor in global warming and climate change.

This report is based on a meta study on the environmental impacts of mined diamonds. The environmental impacts of mined diamonds are quantified in Table A.1 below.

Table A.1 Quantifying the environmental impact of mined diamonds [Sources: (Lord et al., 2019), (Cano Londoño, 2019), (Shah, 2014),(ICMM, 2012) ("Environmental performance," 2009), (Agwa-Ejon and Pradhan, 2018)]

Metric (per carat)	Low value	High Value	Median
Carbon footprint (kg CO_2e)	57	160	108.5
Air Quality (particulate matter, kg)	0.4	1.86	1.13
Land waste (hectares)			0.00091
Water consumption (m^3)	0.48	7.3	3.89
Heavy metal in the soil (tonnes)	2.63	2.72	2.675
Land use (Sq ft)	100	272	186
Tons of earth extracted	250	1750	1000
Production weighted average GHG emissions (kg CO_2)	287	736	511.5
Energy use (kWh)	52	150	101
Nitrous oxide emissions (tonnes)	0.00086	0.042	0.02143
Sulphur oxide emissions (tonnes)	0.00051	0.014	0.007255
Waste rock (kg)			4350
Industrial waste (kg)			1.86

Chapter 1: Introduction

1.1 Background

Mining is the fifth largest industry in the world. It plays a crucial role in world economic development, and the trade of mineral commodities represents a substantial part of international markets. Around 147 million carats were mined in 2018, with a worldwide market value estimated at $76bn, according to data analyst Statista – 29% was from Russia, 11% from Democratic Republic of Congo, 16% from Canada. The Republic of Sakha (Yakutia) has a rich diversity of mineral resources and produces 99 per cent of Russia's diamonds, worth annually US$1.5 billion and amounting to between 20-25 % of the world's output (Yakovleva et al., 2000). Data from the 2016 U.S. Geological Survey states that Russia produces the most gem-quality diamonds—housing half of the world's largest diamond mines — followed by Botswana, Canada, Angola, and South Africa. But the coveted title of "world's largest diamond mine" varies.

Mineral resource exploitation also causes irreversible damage to the natural environment including deforestation, soil disturbance, air emissions, surface water pollution, groundwater contamination, dust, noise, workplace health and safety, and others. Mining plays a vital role in the growth and development of any nation in the world. The impact of diamond mining can go far beyond the immediate area of operations via infrastructure developments such as roads, railways and townships for employees, and it can also influence the local community via public health impacts and property rights in relation to indigenous cultures. Mining and its industries are critical for the socio-economic development of a country. However, the negative environmental impacts could outweigh the positive benefits if not checked.

The major diamond producing countries are shown in Figure 1 below. Figure 1 shows the estimated annual production of gem-quality diamonds, in millions of carats, for the world's leading diamond producing nations. The top five countries based on diamond production are Russia, Botswana, Australia, DR Congo, and Canada. Figure 2 below also shows countries with at least 50,000 carats of natural gem-quality diamond production in 2019. The map clearly shows that natural diamond production occurs in many parts of the world (King, 2019).

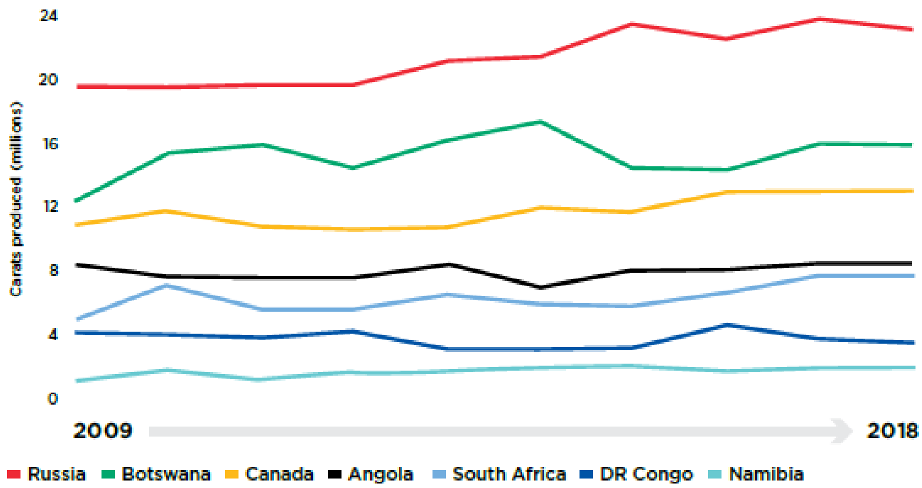

Figure 1 Major diamond producing countries [source: (US Geological Survey, 2020)]

Figure 2 countries with at least 50,000 carats of natural gem-quality diamond production in 2019 [source: (King, 2019)]

Figure 3 below is a graph of the production history of selected gem-quality diamond producing countries. Values for 2019 are estimated. Graph by Geology.com. Data from USGS Mineral Commodity Summaries, Sustainable Minerals Institute.

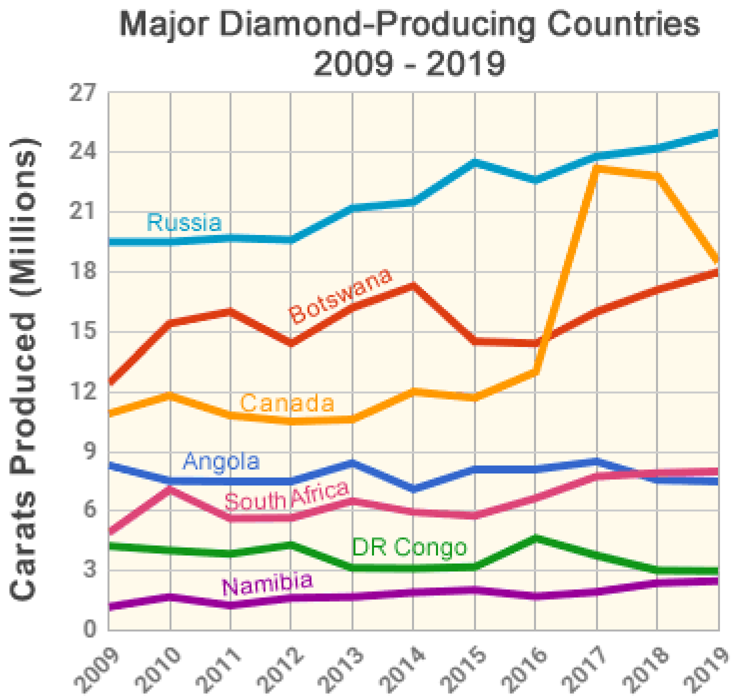

Figure 3 Graph of the production history of selected gem-quality diamond producing countries [source: (King, 2019)]

Diamond production from other parts of the world is about 7million carats as shown in Figure 4 below. The global diamond production in 2019 was 142 Million carats (BAIN & COMPANY, 2019).

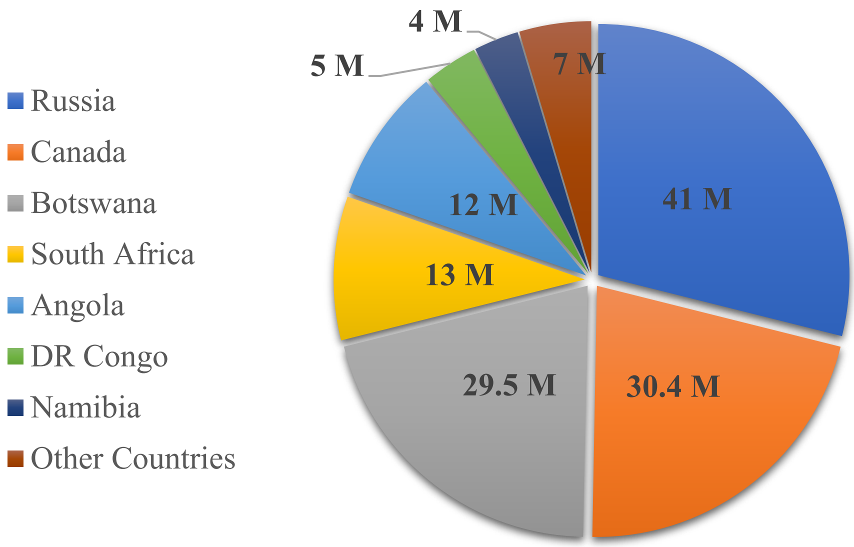

Figure 4 Top Gem diamond producers in millions of carats Graph of the production history of selected gem-quality diamond producing countries [source: Data from (BAIN & COMPANY, 2019)

1.2 Country Specific Diamond Production

Most of Russia's diamond production to-date has been from open-pit mines at the Mir and Udachnaya pipes in the Siberian Republic of Sakha. ALROSA, a Russian group of diamond mining companies, produces almost all the diamonds mined in the country. Botswana's Jwaneng mine is often referred to as "the richest diamond mine in the world." The mine has been producing about 10 million carats of high-quality diamonds per year. The mine is owned by a company named Debswana, a joint venture company between De Beers and the government of Botswana - hence the name "Debswana." Some of Canada's mines have already been closed due to difficult mining conditions or ore bodies being worked out (King, 2019). However, the country's position as the third-leading producer of diamonds in the world has been maintained. Most of Canada's mines are in remote and frigid locations in the northern part of the country. Some can only receive their heavy supplies by trucks that travel on ice roads that can only be crossed during the coldest months of the year. The mines must also have all the facilities needed to house and support their employees for months at a time. In recent years, production in Australia has fallen sharply as deposits there have been depleted with insufficient discoveries to replace them. In 2013, Rio Tinto opened the new Argyle underground diamond mine in Western Australia. The open pit mine at Argyle had been a steady producer of diamonds since 1983 and the world's leading source of natural fancy-coloured diamonds. The underground mine should extend Argyle's life until at least 2020 (King, 2019).

Mining is widely regarded as having adverse effects on environment of both magnitude and diversity. Some of these effects include erosion, formation of sinkhole, biodiversity loss and contamination of groundwater by chemical from the mining process in general and open-pit mining in particular.

1.3 Diamond Mining Processes

There are four major variations of mining. Diamonds are mined through four types of diamond mining: open-pit mining, underground mining, alluvial mining, and marine mining.

1.3.1 Open-pit mining

This involves removing the layers of sand and rock found just above the kimberlite. Kimberlite occurs in the Earth's cursy as an igneous tock in vertical structures known as Kimberlite pipes.

Kimberlite pipes are created as magma flows through deep fractures in the Earth. Kimberlite pipes are sources of mined diamonds. Open-pit diamond mining is used closer to the earth's surface, as miners remove the layers of sand and rock just above the kimberlite rocks. Once exposed, the ore in the pit is broken up by blasting. A single blast can break approximately 3,000 tonnes of ore. Once the ore is broken, excavators load the ore into haul trucks and transport it to a primary ore crusher where diamond extraction begins. The Kimberley Big Hole is an example of open-pit mining. The world's largest diamond mine, the Debswana-owned Orapa project in Botswana, uses open-pit mining to extract diamonds located up to 250 metres below the surface. In 2015, the mine extracted over 9.6 million carats, and its owners aim to extend operations to 450 metres below ground, further extending the project ("How are diamonds mined?," 2018).

1.3.2 Underground mining

In underground mining, miners tunnel through Earth's crust to the kimberlite pipe. Tunnels are constructed in two levels, one above the other with funnels built to connect the two. Mining begins on the top level by blasting ore, which falls through the funnels and collects on the second tunnel. Here, loaders collect the broken ore and bring back to the surface for processing. underground mining requires the creation of two parallel and vertically connected tunnels where miners in the top tunnel blast the ore of the kimberlite pipes which falls and collects on the bottom tunnel. The Jubilee mine in Sakha, Russia, uses an extraction method known as pipe mining. This involves embedding shanks into long cylinders of kimberlite ore, known as 'pipes', and digging up large amounts of soil ("How are diamonds mined?," 2018). This soil is then transported off-site, where it is processed at specialised facilities to separate rough diamonds from the majority of the soil. The operations have been effective, as Jubilee is Russia's largest mine with a production of 9 million carats in 2015 from estimated reserves of 125.4 million carats ("How are diamonds mined?," 2018).

1.3.3. Alluvial mining

Over thousands of years, the kimberlite pipe that reaches the Earth's surface is eroded and weathered by wind, rain, rivers, and streams. Alluvial mining occurs in riverbeds and beaches, where thousands of years of erosion and natural forces such as wind, rain, and water currents wash diamonds from their primary deposits in kimberlite pipes to beaches and riverbeds. The eroded kimberlite bears rough diamonds, which are carried downstream. The first diamonds discovered in South Africa were from alluvial deposits.

Today, industrial alluvial mining involves building a large wall to collect the water in one area. Diamonds are often found in the gravel layer, which collects under layers of other material, such as mud, clay and underwater plant-life. Once the gravel is collected, it is hauled to the surface and prepared for processing. Miners build walls or divert rivers to expose the diamond-bearing dry river or ocean bed. While workers initially sifted through the sand at the original site, the process soon advanced, with sand being transported to a screening facility to be more efficiently processed ("Petra Diamonds | How are diamonds mined by Petra?," n.d.). Alluvial mining presents a better environmental and social behaviour, while open-pit mining presents a better economic dimension (Cano Londoño, 2019).

1.3.4 Marine mining

Marine mining involves extracting diamonds from the seabed/ ocean floor, hundreds of meters under water. The earliest form of marine mining entailed shore diving, where a swimmer would collect diamond bearing gravel from the shallow seabed. Today technology has evolved to specialised ships that mine for diamonds deep out at sea. These specialised ships use a powerful crawler that sucks gravel on the seabed up through flexible hoses/pipes. Alternatively, they use a large-scale drill mounted to the ship to excavate diamonds. The coast of Namibia is the richest known source of marine diamond deposits which account for approximately 64% of Namibia's total diamond production. While the earliest form of marine diamond mining laboriously required a swimmer to collect gravel from a shallow seabed, modern technology granted access to greater depths through horizontal and vertical marine mining. Horizontal marine diamond mining uses a crawler to suck gravel from the ocean floor to the surface via flexible pipes, while vertical diamond mining uses a large, ship-mounted drill to pull up the diamond-bearing gravel. A summary of all four mining methods is provided below:

Open-pit mining
- Removing layers of sand and rock found just above kimberlite
- Most of Russia's diamond production has been from open-pit mines

Underground mining
- Miners tunnel through Earth's crust to the kimberlite pipe
- Underground mines used in Australia to extend life of open-pit mine

Alluvial mining
- Diamond deposits removed from kimberlite source and deposited in river beds etc

Marine mining
- Extracting diamonds from the seabed, hundreds of meters under water.
- Coast of Namibia is the richest known source of marine diamond deposits

Figure 5 Summary of diamond production methods

1.4 Methodology

A meta study into the environmental impacts of diamond mining was conducted covering a detailed environmental impact assessment, focusing mainly on the production process. The meta study involves a review of the academic, industrial and grey literature on diamond production processes. Datasets were collected from USGS, company reports and published literature. Only publicly available datasets were used. Interviews would also be conducted with identified experts in this remit.

The data gathered was normalised and supplemented with extrapolation techniques to produce a comprehensive database of environmental metrics for diamond mining. For standardising the datasets, the collected sets of data will be quantified, averaged, and represented on a per carat metric basis – based on total impacts divided by total production.

Country-specific case studies were also conducted to account for the location of the mine. Country-specific case studies are relevant since technology mix, heat mix, and electricity mix vary from one country to another.

The focus of the study lies with the production process, including the following factors:

- *Environmental impact metrics:*

  The environmental impacts encompass both primary and secondary impacts: greenhouse gas emissions (using the global warming potential, carbon footprint, ozone depletion potential), biodiversity impacts, air quality, land use and impacts (including erosion, terrestrial acidification) and waste, water consumption, noise, wildlife impacts, vegetation diversity (based on heavy metal in the soil), aquatic ecosystems, ground failures, metal depletion, human toxicity, freshwater toxicity, energy footprint (cumulative energy demand), fossil fuel depletion, and smog potential. The factors were selected to enable discussion of the congruence between production activity and the sustainable development goals – SDG 2, SDG 7, SDG 12, SDG 13, SDG 14, and SDG 15.

- *Four variations of the major production process:*

  Preliminary literature survey shows there are four major variations of the production process of the client's competitor. The environmental impacts of these variations are different.

- *In-depth study of the dominant production process (identified as open cast mining):*

  Assess the environmental impacts of producing one carat diamond from open cast mining using the above metrics.

- *Five Country specific case studies around the dominant production process*

  Assess the environmental impacts of the largest producing open cast mines located around the world. This will be done by selecting five of the top ten mines based on data availability and will be discussed during the interim meeting.

Chapter 2: Environmental Impacts of Mined Diamonds

Environmental risks and impacts vary from operation to operation, and region to region, and the primary environmental concerns associated with diamond mining are water and energy conservation, optimising resource usage and waste management, biodiversity and closure management. Constant measurement and monitoring of key characteristics need to take place in order to prevent potential pollution and to mitigate actual pollution to air, land and water.

The diamond mining industry involves water intensive processes that allow diamonds to be liberated from the host rock. The most significant potentially-polluting process is the crushing of the kimberlite ore during which dust is generated. This dust gets trapped in the water and is referred to as suspended solids. The contaminated water is pumped into settling or slimes dams where the suspended solids sink to the bottom. The clean water is then recycled back into the system through penstocks that are situated at the top of the water level in the dams. This is as much a cost saving initiative as it is an environmental imperative. Importantly, no harmful reagents are used to liberate the diamonds. Iron silicate is used in the processing of kimberlite ore as this assists with dense media separation (to separate diamonds from the rock).This is reclaimed, however, and not released into the environment again both for environmental and cost reasons.

Disturbance of the land on which its operations are located is the most lasting and visible environmental impact of diamond mining. There is need to rehabilitate land to appropriate land use where this is possible.

Today most modern diamond mines are managed to the ISO 14001 standards of environmental management, and the major companies have a policy of regularly publishing reports on their environmental performance.

The environmental impacts also depend on the mining process. In open pit mining, geological structures called Kimberlite pipes (funnel-like tubes of rock which extend far into the depths of the Earth) are mined to extract the diamonds. Because they are so deep and so old (the youngest known Kimberlite pipes are several tens of millions of years old), they are found in the ground often beneath overburden (such as sand and soil). This means that large quantities of surplus waste rock, sand, soil and processed Kimberlite can accumulate in the immediate vicinity of such areas which need to be managed accordingly and rehabilitated. For both coastal and inland alluvial mining – When diamond deposits are found in coastal areas, mining companies may be required to remove soil and plant life before they begin mining. Mining of beaches and inland alluvial diamond deposits can also require the removal of overburden (such as sand and soil) and the construction of sea-walls. This kind of mining does result in large-scale excavation along coastal areas and modification of the land. Once the mining is complete, soil and plant life need to be replaced and the visual impact and the impact on the surrounding land also removed over time by wind and wave motion. In areas with very low rainfall, special techniques need to be applied to re-vegetate the area. In marine mining, diamond deposits are sometimes found on the seabed, seabed matter needs to be removed from marine diamond mining sites to access the diamonds beneath. To minimise the impact on the environment, the seabed matter is replaced in its original position.

In an interview with Professor Saleem Ali[1] an expert on sustainable mining and a Blue and Gold distinguished Professor of Energy and the Environment, the bigesst environmental impact of mined diamonds was discussed "The most significant impact of mined diamonds in environmental terms is likely to be land disturbance and the overall magnitude of this is dependent on the ecosystem in which the mining is occurring. There can be additional water use and biodiversity impacts dependent on where the mining is occurring. The carbon emissions of mining are highly dependent on location. Cold climates such as Siberia or Northern Canada have larger carbon emission impacts. Artisanal alluvial diamond mining has less carbon emission impacts." – Saleem Ali.

Environmental challenges associated with diamond mining are grouped into impacts on water resources, air quality, wildlife, soil quality and climate change considerations. A qualitative impact assessment is provided below:

2.1 Qualitative Environmental Impacts

- Impacts on water resources. Mining affects water quality and availability of water resources within the project area. There is potential for acid mine drainage and contaminant leaching. Erosion of soils and mine wastes into surface waters, impacts of wet tailings

[1] Saleem Ali (08/10/2020). Blue and Gold Distinguished Professor of Energy and the Environment. University of Delaware, Dept. of Geography & Joseph R. Biden Jr. School of Public Policy and Administration. 220 Pearson Hall, Newark DE 19716, USA Office Phone: +1-302-831-0871 Interview conducted by Gbemi Oluleye

impoundments, waste rock, heap leach, and dump leach facilities on water quality which can be severe.

- Impacts of mining on air quality. waste piles containing small size particles are easily dispersed by the wind. Largest sources of air pollutions are from particulate matter transported by the wind and gas emissions from combustion of fuels in stationary and mobile sources.
- Impacts of mining projects on wildlife. Mining affects the environment and associated biota through the removal of vegetation and topsoil, the displacement of fauna, the release of pollutants, and the generation of noise.
- Impacts of mining projects on soil quality. Mining can contaminate soils over a large area. Agricultural activities near a mining project may be particularly affected. Whilst the alluvial diamond mining loosens the soil the heavy vehicles and machinery have the effect of hardening the soil. The loose sediment is easily carried away by the increased runoff because of the hard surfaces increasing sediment input into Rivers and the small dams in the area. Other impacts are deforestation, land degradation, biodiversity impact (i.e. change in both the aquatic and terrestrial habitats has a profound effect on biodiversity), an issue that needs further investigation. Mining operations have drastically changed habitats in addition to increasing human population. Wildlife seems to have been squeezed out by the human population while mining operations create an environment unsuitable for the survival of many biological species.
- Climate change considerations. Lost CO_2 uptake by forests and vegetation that is cleared, and CO_2 emitted by machines (e.g., diesel powered heavy vehicles) involved in extracting and transporting ore. Diamond exploration and mining use two forms of energy: electricity and hydrocarbons (diesel, marine gas, oil and petrol). A by-product of both electricity and hydrocarbon energy is the release of carbon emissions into the air, such as CO_2 (a naturally occurring gas). Carbon emissions are considered to be a major factor in global warming and climate change. Industrial activity (including the production and use of electricity) creates emissions – greenhouse gases – and other chemical (synthetic and natural) substances. These are released into the air and cause a range of environmental problems, from climate change to smog, which threaten our health and our environment. Reducing energy consumption helps to protect the planet.

2.2 Quantitative Environmental Impact Metrics

The metrics measuring the environmental impact of any mining activity is provided in Figure 6 below (i.e. midpoint impact category). Figure 6 also shows damage pathways and endpoint area of protection for each metric.

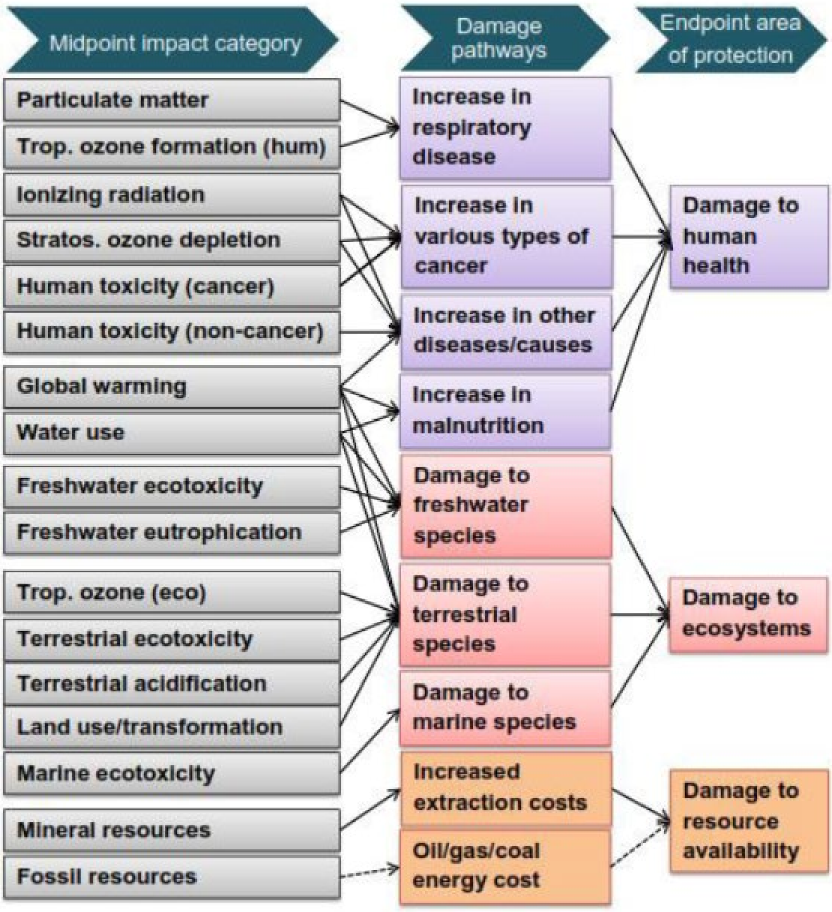

Figure 6 Environmental Impact metrics for mining and damage pathways

The environmental impacts encompass both primary and secondary impacts: greenhouse gas emissions (using the carbon footprint, production weighted average greenhouse gas emissions, nitrous oxide emissions, and energy use), biodiversity impacts, air quality, land use and impacts (including erosion, terrestrial acidification) and waste, water consumption, noise, wildlife impacts, vegetation diversity (based on heavy metal in the soil), aquatic ecosystems, ground failures, metal depletion, human toxicity, freshwater toxicity, energy footprint (cumulative energy demand), fossil fuel depletion, and smog potential.

A review of academic, industrial and grey literature on diamond production processes was conducted to quantify the environmental impact based on the metrics. The minimum and maximum value for each metric was used to establish a range, and the average found. Some selected environmental impacts of mined diamonds are provided in Figure 7, and Table 1 contains the minimum, maximum and average values.

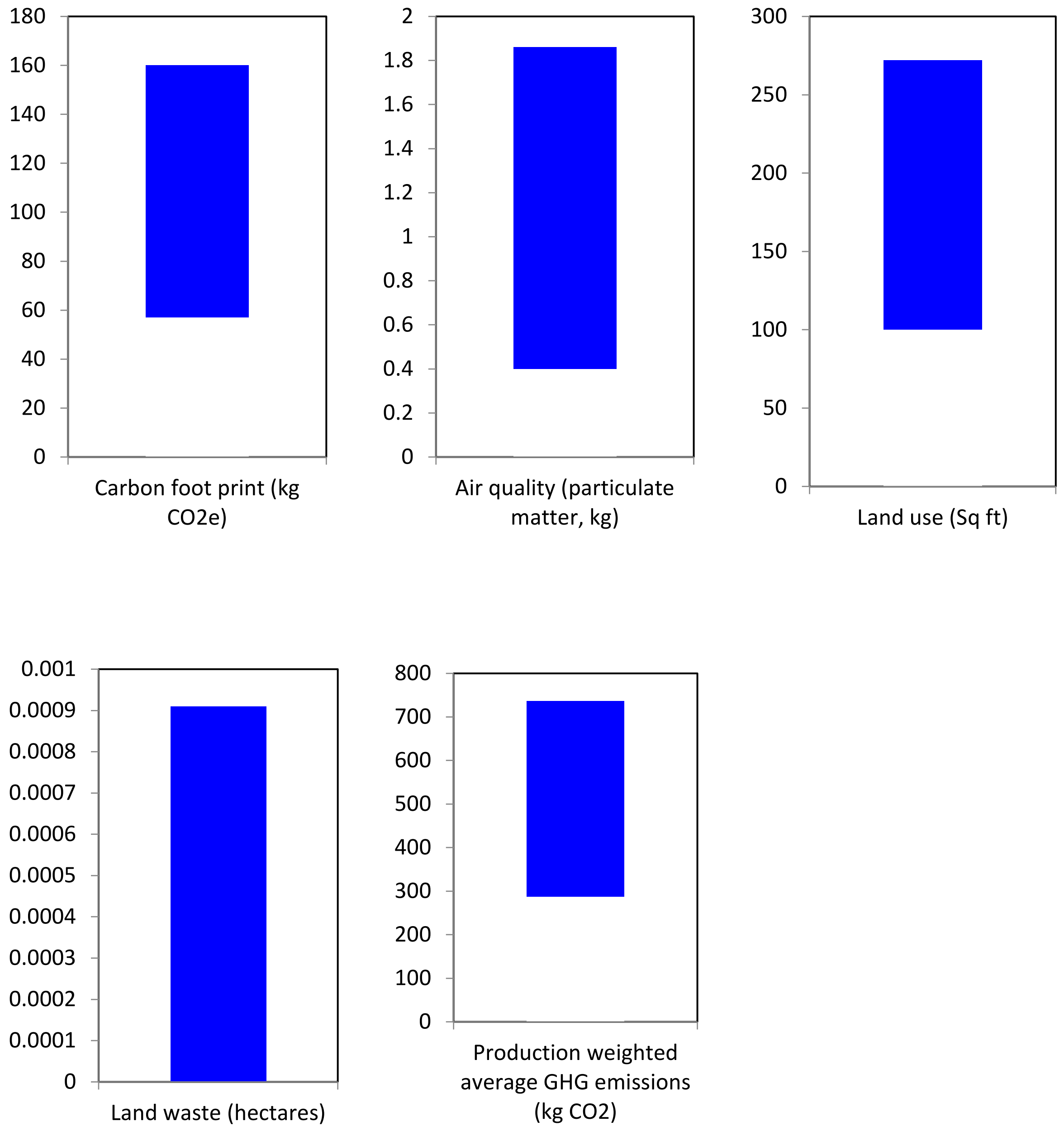

Figure 7 Selected environmental impact metrics for mined diamonds

Other impacts are provided in Table 1 below.

Table 2 Quantifying the environmental impact of mined diamonds [Sources: (Lord et al., 2019), (Cano Londoño, 2019), (Shah, 2014),(ICMM, 2012) ("Environmental performance," 2009), (Agwa-Ejon and Pradhan, 2018)]

Metric (per carat)	Low value	High Value	Median
Carbon footprint (kg CO_2e)	57	160	108.5
Air Quality (particulate matter, kg)	0.4	1.86	1.13
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Sulphur oxide emissions (tonnes)	0.00051	0.014	0.007255
Waste rock (kg)			4350
Industrial waste (kg)			1.86

The metrics in Table 1 were selected to enable discussion of the congruence between production activity and the sustainable development goals – SDG 2, SDG 7, SDG 12, SDG 13, SDG 14, and SDG 15. An interview with Dr Gavin Mudd[2] an expert on sustainable mining reinforced the choice of metrics in Table 1. His words were 'this report covers all the important metrics for environmental impact of mined diamonds'.

Air, land and water pollution emissions due to energy use and other processes on the mine site also represent a significant impact of diamond mining at 6% of total impacts. The same metrics were considered by various authors such as Lord et al., 2019 who considered five major environmental indicators category – biodiversity conservation; air, land and water pollution; climate change; water consumption; waste and land use. Additionally, in most data sources normalisations were done based on the maximum value of each index per both systems and product levels. However, some experts push back on the report authored by Lord et al., 2019. For example Saleem Ali, professor of energy and the environment at the University of

[2] Gavin Mudd (16/09/2020). Department of Environmental Engineering RMIT University, Australia. Interview conducted by Gbemi Oluleye

Delaware "I think their estimates on greenhouse gas emissions and energy usage are very questionable," (Vogue, 2019). Statement from another expert Gavin Mudd[1] (2020) is 'I use the data but do not trust it'. Gavin Mudd[1] also mentioned the big lack of data in this space due to the diamond mining industry not used to the culture of transparency. Another perspective from Prof Saleem Ali[1] on the report authored by Lord et al., 2019 is "The DPA report did not consider the full life cycle of diamond mining -- exploration operation and closure".

The emissions produced, total fuel consumption, water usage and energy usage impacts from 6 countries – Canada, Australia, Zimbabwe, South Africa, Botswana and Tanzania are shown below for both open pit and underground mining. The bar charts are for different mines located in the countries.

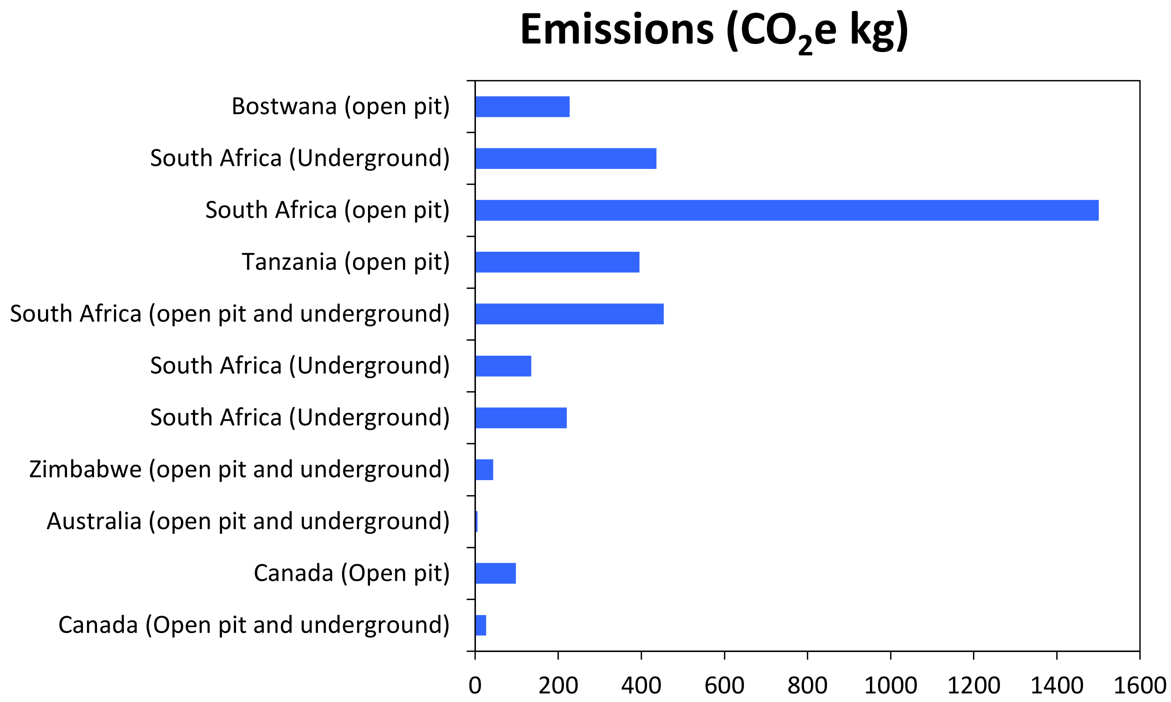

Figure 8 Country-specific and mine specific impact (CO_2 emissions)

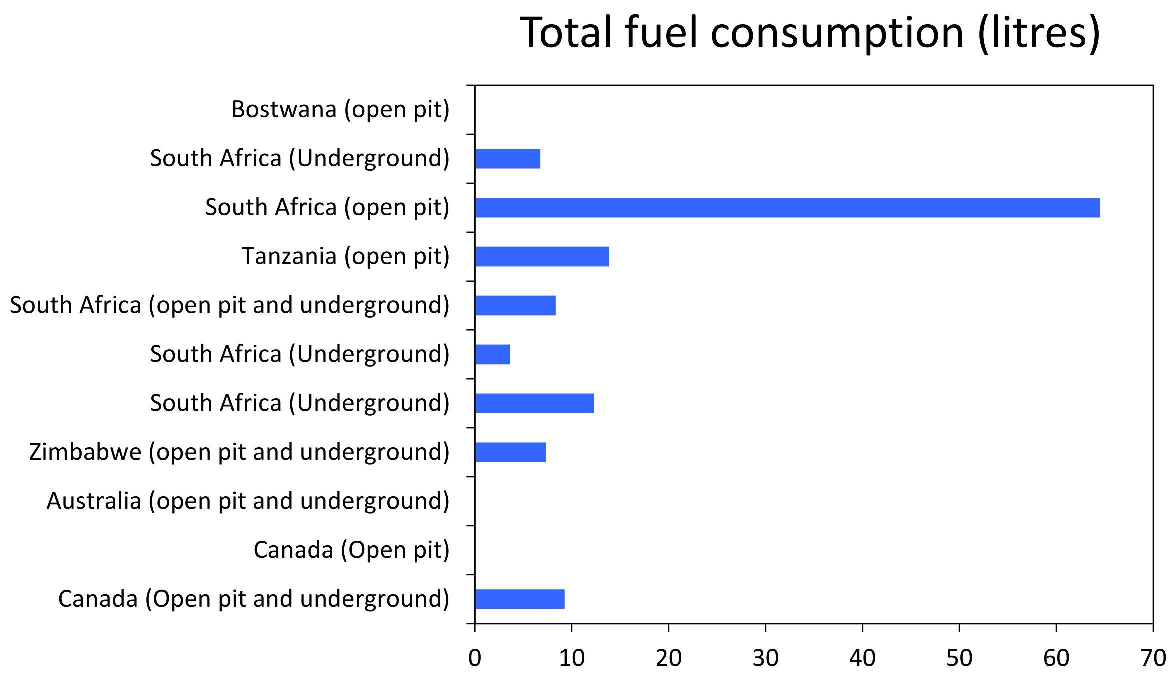

Figure 9 Country-specific and mine specific impact (fuel consumption)

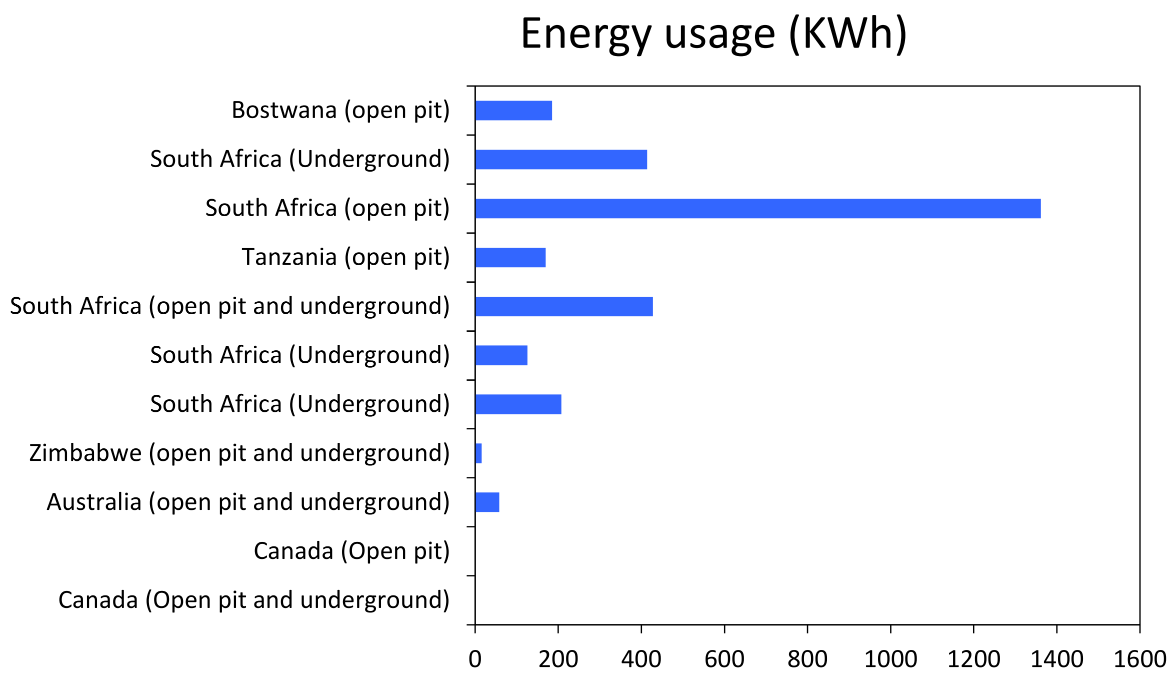

Figure 10 Country-specific and mine specific impact (energy consumption)

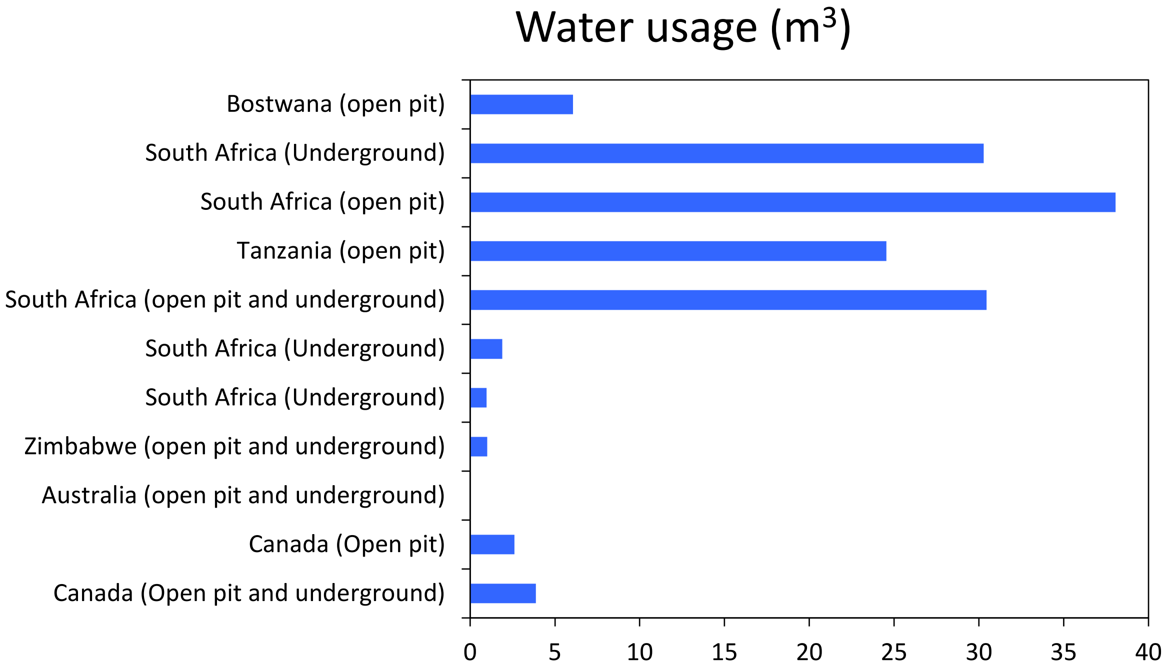

Figure 11 Country-specific and mine specific impact (water consumption)

The values from Figures 8 to 11 are show in Table 2 below.

Table 3 Quantifying the environmental impact of mined diamonds per carat [Sources: (Lord et al., 2019), (Cano Londoño, 2019), (Shah, 2014), ("Environmental performance," 2009)] (Frost & Sullivan, 2014)

	Energy usage (KWh)	Emissions (CO_2e kg)	Total fuel consumption (litres)	Water usage (m3)
Canada (Open pit and underground)	-	26	9	4
Canada (Open pit)	-	98	-	3
Australia (open pit and underground)	58	6.88	-	0.0021
Zimbabwe (open pit and underground)	15	43.88	7	1.01
South Africa (Underground)	207	221	12	0.974
South Africa (Underground)	125	135	4	1.901
South Africa (open pit and underground)	428	454	8	30

Tanzania (open pit)	170	395	14	25
South Africa (open pit)	1362	1501	64	38
South Africa (Underground)	414	436	7	30
Bostwana (open pit)	185	227	-	6

Other impacts sch as number of environmental incidents, occupational disease rate are provided in Appendix A (Table A.1). The environmental cost was expressed as true price gap for mining in ("The True Price of Diamonds," 2017). The true price gap attempts to cost environmental damage per carat of mined diamonds. The true price gap are all direct external costs not necessarily part of the price tag but paid for. Examples are what local communities would pay for damage to air and water pollution, future generations pay for climate change, employees pay for heat and safety costs. The direct external costs in the true price are harmful to society. The true price method provides businesses with insight to improve their societal impact by reducing its true price gap. The environmental impacts in the above diagrams are for climate change, air pollution, water pollution, water use, energy use, land use. The true price gap for large scale mining, artisanal mining, and laboratory-grown diamonds are provided in the Figures 12 to 14 below.

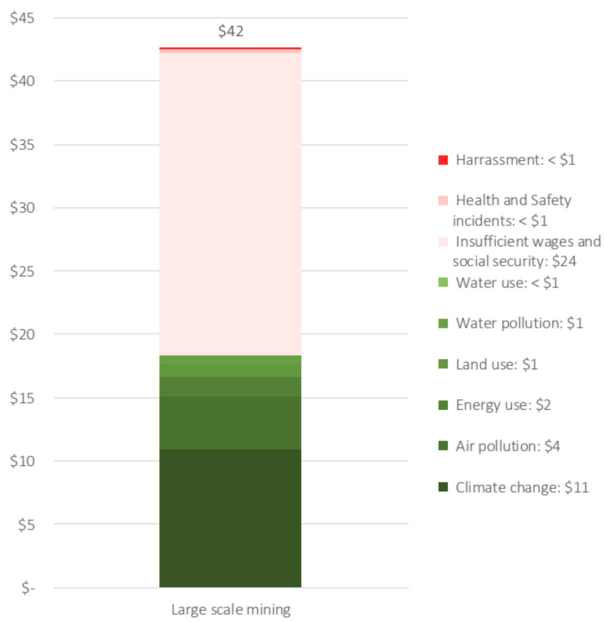

Figure 12 True Price gap for large scale mining ($/carat polished diamond). [Source: ("The True Price of Diamonds," 2017)]

Figure 13 True Price gap for artisanal mining ($/carat polished diamond). [Source: ("The True Price of Diamonds," 2017)]

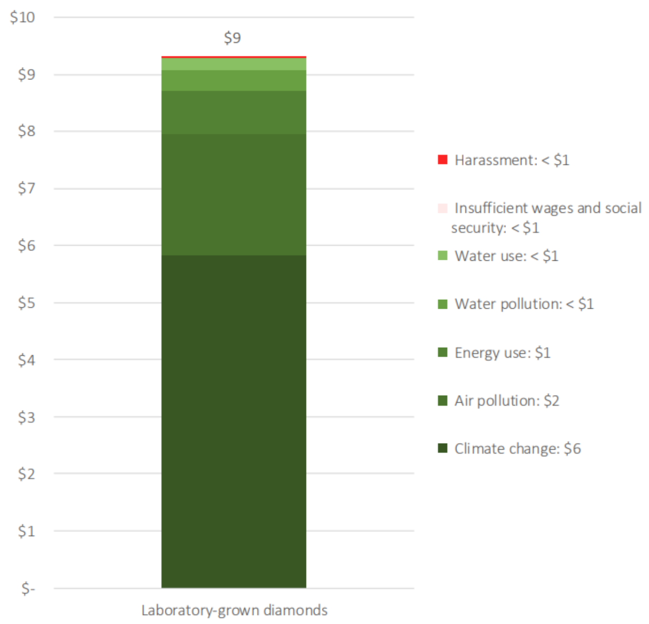

Figure 14 True Price gap for laboratory-grown mining ($/carat polished diamond). [Source: ("The True Price of Diamonds," 2017)]

Chapter 3: Summary and Conclusions

A meta study was conducted to evaluate the environmental impact of mined diamonds. Diamond mining has many detrimental impacts on the environment including soil erosion, deforestation, and ecosystem destruction. The impact categories assessed in the study are provided in Chapter 3. Diamond miners have re-routed rivers and constructed dams to expose riverbeds for mining, with disastrous effects on fish and wildlife. Specifically, Caribou (wild riendeer) bears and fish would lose their habitats and die off because of the huge area these mine sites cover ("The Catastrophic Effects Of Mining Diamonds | Ethica Diamonds UK," 2019). When water bodies get drained, all the fish and other creatures living there are killed. Chemicals dangerous to water fleas are present when the kimberlite rock gets processed, the whole food chain is affected when the fleas die off. In extreme cases, diamond mining can cause entire ecosystems to collapse. Furthermore, the mining stage has the most negative impact on society. The working conditions in most of the countries diamonds are mined in are terrible. The Ekati diamond open pit mine in Canada alone needed 40kg of building materials, machinery, diesel and food, which are all moved by giant trucks along the 475km ice road leading into the mine (Couch, 2002). The environmental footprint was 1400 hectares of land. Another environmental impact is the loss of land-based habitat for wildlife such as caribou, grizzly bears, and wolverine. For instance, radio-collared cows from the Bathurst caribou herd spend 7-8% less time feeding near the Ekati mine. The caribou migrate through the mining area, but the huge amounts of dust contaminate the lichen which the caribou eat. Also, the other vegetation which the caribou eat get wiped out because of excavating the mines. The population of caribou declined from 400,000 to 128,000 between the 1980's and 2006. Loss of fish habitat through draining of lakes, destruction of streams, changes in water quality is also an impact of the Ekati mine. Water quality changes are measurable as far as 200 km downstream of Lac de Gras (Ekati mine), and there have been irreversible changes to water quality and possibly species composition in Snap Lake. Twenty lakes have been eliminated altogether, with no fish habitat compensation measures in place. Both Ekati and Diavik diamond mines are currently fuelled by millions of litres of diesel. Each mine makes a significant contribution to the greenhouse gas produced by the Territories every year.

The Argyle mine in Western Australia, for example, has a fuel usage of 4.2 pounds per carat, whereas the Diavik mine in northern Canada uses fuel at 11.5 pounds per carat, thanks to its harsh climatic conditions as well as the geological location of ore bodies (Ali, 2017). The average energy needed to produce diamond from Argyle diamond mine is 7.5 kilowatt- hours per carat, while Diavik uses 66.3 kilowatt- hours per carat. De Beers, which has a diversified mining portfolio that also includes marine diamond mining off the Skeleton Coast of Namibia, consumes an average of 80.3 kilowatt- hours per carat (Ali, 2017).

Diamond mining companies insert large amounts of ammonia under the lake beds to help extract minerals. This harms the fish that live there. These toxic chemicals pollute the air in the area and contaminate surrounding lakes. These toxic chemicals from the mines may also end up in neighbouring communities due to wind carrying the pollutants. When an open pit mine closes down, it usually becomes a landfill, but this would be unsafe for the ecosystem (burrowing animals, chemicals, etc.), Soil degrades meaning that no plants would grow in the surrounding. Dust particles created by the open-pit mines contribute to ground level ozone. This is a gas pollutant created by the emissions from industrial facilities, motor vehicle exhaust, gas vapour, etc. Inhaling the gases causes lung problems, throat pain and asthma. In addition, it can also damage crops, trees, vegetation growth. Machinery used in open-pit mines runs on chemicals that can destroy or weaken upper ozone layer in those areas, which cause carcinogenic radiation, and damages crops.

The diamond industry would like consumers to believe that the benefits of formal (regulated) mining far out way the environmental impact, however, the truth is that mining is catastrophic to eco-systems, the environment and its indigenous people (“The Catastrophic Effects Of Mining Diamonds | Ethica Diamonds UK,” 2019). So-called “conflict-free” Canadian diamond mines are located in areas with environmentally fragile ecosystems, have significant ecological footprints, and will significantly impact upon the caribou, wolverine, bears, ptarmigan and fish which provide food for Indigenous people. Therefore, they cannot be classed as conflict-free or ethically sourced in the truest sense. One final thing to remember is that mined diamond companies may conveniently forget to include impacts from all the test-digging that went on before they started on the actual productive mine.

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Appendix A: Other Impacts of mined diamonds

Table A.1

Parameter	Impact per carat
Number of environmental incidents	4.5
Lost Time Injury Frequency Rate	0.115 injuries per 100 employees per year
Lost Time Injury Severity Rate	8.015 days per 100 employees per year
Occupational Disease Rate	0.075 incidents per 100 employees per year

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