

# Beneath the Green

## A critical look at the environmental and human costs of industrial cobalt mining in DRC

### ANNEX 1 SELECTED SCIENTIFIC STUDIES ON THE ENVIRONMENTAL IMPACTS OF MINING IN THE DRC'S COPPER-COBALT BELT

#### Theme: Water Pollution

Study/Author	Region	Findings
'Evaluation of the sanitary quality of the water consumed by the population of the Sambwa mission village in the Democratic Republic of Congo' (Kilufya Kalomo Kitikimo and Banza, 2022).	Lubumbashi, DRC	The study demonstrates that the quality of water (from the river and wells) consumed by local residents in Sambwa (near Lubumbashi) is contaminated by various pollutants, including mining and industrial, and constitutes a danger to human health. Analysed water contained levels of arsenic, cadmium and antimony that were above the WHO safe drinking standard.
'Impact of mining on water of the rivers Shinkolobwe, Lwisha and Kansonga in the province of Katanga (DRC)' (Mudimbi Kalonda et al., 2017).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study investigates the impact of mining on water quality in the Shinkolobwe rivers, Lwisha and Kansonga of the Katanga province. Examined water bodies were found with concentrations of lead and cadmium that were beyond required limits.
'Diagnosis of water contamination of the river Mulungwishi by metal trace elements (ETM) : Lubumbashi, Haut Katanga / RD Congo' (Kalala et al., 2016).	Lubumbashi, DRC	The study assessed the levels of trace metals (Cu, Co, Fe, Mn, Mg) <sup>1</sup> in the Mulungwishi River. It reveals high metal concentration, with Cu and Co exceeding WHO standards due to a gravel production plant and artisanal copper and cobalt mining.
'Evaluation de la contamination de la chaîne trophique par les éléments traces (Cu, Co, Zn, Pb, Cd, U, V et As) dans le bassin de la Lufira supérieure (Katanga/RD Congo)' (B. Katemo Manda et al., 2010).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study confirms the pollution of the Upper Lufira Basin in the Congolese copper-cobalt belt by ore washing and effluents from industrial ore processing plants discharged into watercourses without prior treatment. It analysed and found high metal concentrations in water, plankton, leaves of <i>Phragmites australis</i> [common reed], muscle and fish.

<sup>1</sup> Cu= Copper; Co= Cobalt; Fe= Iron; Mn= Manganese; Mg= Magnesium; Cd=Cadmium; Pb= Lead; Zn= Zinc. Abbreviated periodic table names of these metals are used in the remainder of this Annex.

## Theme: Health impacts of mining pollution

Study/Author	Region	Findings
'Metal mining and birth defects: a case-control study in Lubumbashi, Democratic Republic of the Congo' (Brusselen et al., 2020).	Lubumbashi, DRC	The study investigates the association between trace metal exposure and birth defects. It found that exposure of parents to pollutants through their job in artisanal mines was strongly associated with birth defects. It also noted high Mn and Zn prenatal concentrations.
'Incidence of low birth weight and proximity to mining in Lubumbashi and Kipushi, DR Congo' (Kayembe-Kitenge, 2020)	Lubumbashi, DRC	The study suggests a possible link between mining-related metal pollution and low birth weight due to high exposure to trace metals in people living close to mining areas.
'Sexual dysfunction and mining-related jobs: A cross-sectional study in the former Katanga Province, DR Congo' (Musa Obadia et al., 2020).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study investigates the association between sexual dysfunction and metal exposure in mining-related-jobs. It finds mine workers with lower scores of erectile function and evidence of higher exposure to trace metals, including lead.
'Incidence of congenital malformations and proximity to mining in Lubumbashi, DR Congo' (Kayembe-Kitenge et al., 2019)	Lubumbashi, DRC	The study suggests a possible link between mining-related metal pollution and congenital malformations (including neural tube defects, lower limb defects, cleft lip/palate and abdominal wall defects) due to high exposure to trace metals in people living close to mining areas (i.e. copper and cobalt mines and smelters).
'Sustainability of artisanal mining of cobalt in DR Congo' (Banza et al., 2018).	Kolwezi, DRC.	The study shows exposure to trace metals in people living close to artisanal mining areas. They exhibit high levels of cobalt in urine and blood, with children further exposed to oxidative DNA damage.
'Cobalt and Thyroid Function. Case-Control Study of Patients with Goiters in Katanga, DR Congo' (Kayembe-Kitenge et al., 2018).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study reveals that research participants with an untreated and thyroid function exhibited higher values of trace metals than reference values from industrially developed countries.

## Theme: Water and soil pollution

Study/Author	Region	Findings
'Assessment of Heavy Metal Pollution of Agricultural Soil, Irrigation Water, and Vegetables in and Nearby the Cupriferous City of Lubumbashi, (Democratic Republic of the Congo)' (Mununga Katebe et al., 2023).	Lubumbashi, DRC	The study shows high heavy metal (Cu, Cd, Pb, Co and Zn) concentrations in soils, waters and vegetables due to metal-loaded effluents discharged into watercourses by mining companies and naturally metal-rich soils.
'Impacts of Trace Metals Pollution of Water, Food Crops, and Ambient Air on Population Health in Zambia and the DR Congo' (Muimba-Kankolongo et al. 2022).	Copper-cobalt belt (DRC & Zambia)	The study provides 'compelling evidence of [industrial] mining and metallurgic operations discharging large amounts of toxic metals in the ecosystem causing severe environmental pollution of water, food crops, and ambient air' (p. 11). Mn, Zn, Cd, Pb, and U were 'significantly higher and always far above World Health Organization maximum limits in the DRC' (p. 1). Urine samples showed trace metals with children's samples being more contaminated than adult.
'Economic and Toxicological aspects of copper industry in Katanga, DR Congo' (Kalenga, 2013).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study shows that mining industry is the main source of environmental pollution in Katanga, with Cu, Co, Zn, Pb, and Cd at concentration levels above safe standards in soil, water, plant and fish.

## Theme: Socioeconomic impacts of mining pollution

Study/Author	Region	Findings
'Crop uptake of heavy metals in response to the environment and agronomic practices on land near mine tailings in the Zambian Copperbelt Province' (Kaninga et al., 2021).	Copper-cobalt belt (Zambia).	The results obtained from analysis of farming land adjacent to a large mine tailings dam show that while maize grains showed minimal metal concentrations, stover had substantial amounts of Cd, Cu, Ni, Pb and Zn. They also show pumpkin leaves with large concentrations of heavy metals, including Cu and Pb above the FAO/WHO safety limit, thus representing a danger to consumers.
'Different Degrees of Environmental Contamination by Trace Metals from Mining Activities between DR Congo and Zambia in the African Copperbelt' (Banza et al., 2018)	Copper-cobalt belt (DRC & Zambia)	The study finds that trace metal contamination from industrial mining activities of food intended for human consumption is higher in DRC than in Zambia. In food items, median concentrations (mg/kg) of Co, Cu, Cd, Pb, U were 1.7 to 5.4 times higher in DRC than in Zambia.

## Theme: Health impacts of mining pollution

Study/Author	Region	Findings
‘Congenital Malformations and Trace Metals: A Case-Control Study from Lubumbashi, DR Congo’ (Kayembe-Kitenge et al., 2018).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	Investigating the association between mining environmental pollution and birth defects, the study finds trace metals in urine and blood of research participants in Lubumbashi substantially higher than in global North countries. It also finds that fathers’ work in mining and prenatal Mn exposure were associated with congenital malformations.
‘Trace Metal Exposure and Health Effects among Urban Children Living in Areas with Different Degrees of Pollution in Lubumbashi, DR Congo’ (Musa Obadia et al., 2018).	Lubumbashi, DRC	The study investigates and finds evidence of higher exposure to trace metals, especially cobalt, among children living in Tshamilemba, which is close to a copper and cobalt refinery. The study also finds higher concentrations of cobalt in well water.
‘Human exposure to metals due to consumption of fish from an artificial lake basin close to an active mining area in Katanga (D.R. Congo)’ (Squadrone et al., 2016).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study investigates human exposure to metals from fish consumption from lake Tshangalele, which receives effluents from metallurgical and mining plants in Likasi. It finds high concentrations of cobalt, copper, iron, manganese, zinc and aluminium in fish, posing significant health risks to local residents.
‘Sources of exposure to cobalt and other metals in populations from Likasi and Lake Changalele in Katanga, D.R. Congo’ (Céline Banza and others, in Bohdan Křibek (ed.), Mining and the Environment In Africa (Czech Geological Survey, 2011)).	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study demonstrates that people living close to sources of industrial pollution in Katanga have high concentrations of metals in their urine due from dust and fish consumption. It found high Co concentrations in the liver and kidneys of chickens, and that median Co concentrations in Tilapia fish from Lake Changalele were 10-fold higher than in fish from other locations in the Lualaba.
‘High human exposure to cobalt and other metals in Katanga, a mining area of the Democratic Republic of Congo’ (Banza et al., 2009)	Katanga province (current Lualaba and Haut-Katanga provinces), DRC	The study reveals people living very close to mines or smelting plants have “a substantial exposure to several metals, especially [...] children. The urinary Co concentrations found in this population are the highest ever reported for a general population” (p. 745).

## Theme: Companies' response to environmental pollution.

Study/Author	Region	Findings
'Mining, Waste and Environmental Thought on the Central African Copperbelt, 1950–2000' (Pesa, 2022)	Copper-cobalt belt (DRC & Zambia)	The study demonstrates the underlying power relations between mining companies, governments and fenceline communities, analysing mining companies' and government's "double standards" on environmental damage (p. 25), the legitimacy quest of health concerns, and how local residents have learnt to live with pollution.
'Between waste and profit: Environmental values on the Central African Copperbelt' (Pesa, 2020).	Copper-cobalt belt (DRC & Zambia).	The study shows widespread knowledge of environmental pollution and its impacts on human health among mining companies, which nonetheless approach these issues "in a primarily economic and technocratic manner" (p. 7). For example, the paper finds, "mining companies and water users did not always agree about priorities when faced with a choice between raising profits and securing safe water sources" (p. 4).