



HOKKAIDO
UNIVERSITY



1st International KAMPAI Symposium

Sustainable Management of Resources and Environment in the 21st Century

CURRENT TRENDS OF BLOOD LEAD LEVELS IN KABWE, ZAMBIA

Yared Beyene Yohannes, Yabe J, Nakayama SMM, Haruya T, Nakata H, Kaampwe M, Kataba A, Zyambo G, Mizukawa H, Ikenaka Y, Russell D, Jack C & Ishizuka M

Laboratory of Toxicology



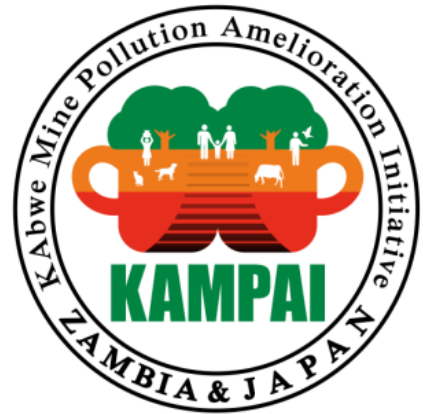
November 6th, 2017



Kabwe Mining Pollution Amelioration Initiative

1

Visualization of impact of chronic/latent chemical hazard & Geo-Ecological Remediation in Zambia



Output 1: Monitoring and risk assessment in Kabwe mining area (and geo-ecological surveillance of broad areas in Zambia)

Output 2: Establishment of economic assessment system for human/animal health and ecosystem and visualization

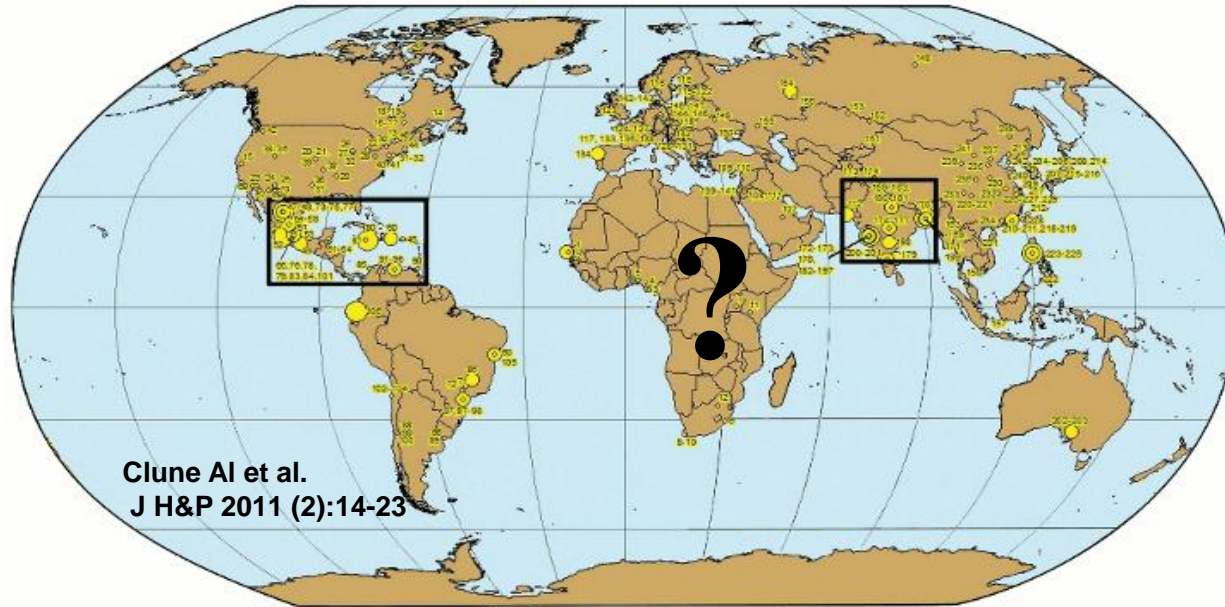
Output 3: Development of geo-ecological database and remediation technology

Output 4: Capacity building

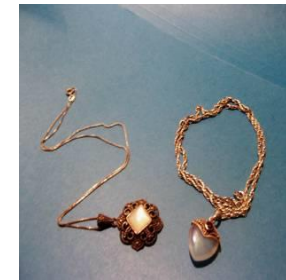
❁ Background

Lead (Pb)

- * Low concentrations in the earth's crust, but widespread in the environment as a result of anthropogenic activity.
- * No known biological role in humans.
- * With the highest burden in developing countries



Map of children's average BLL (from 2000 to 2010)



Toxicokinetics of lead: Absorption, Distribution, Metabolism, and Excretion

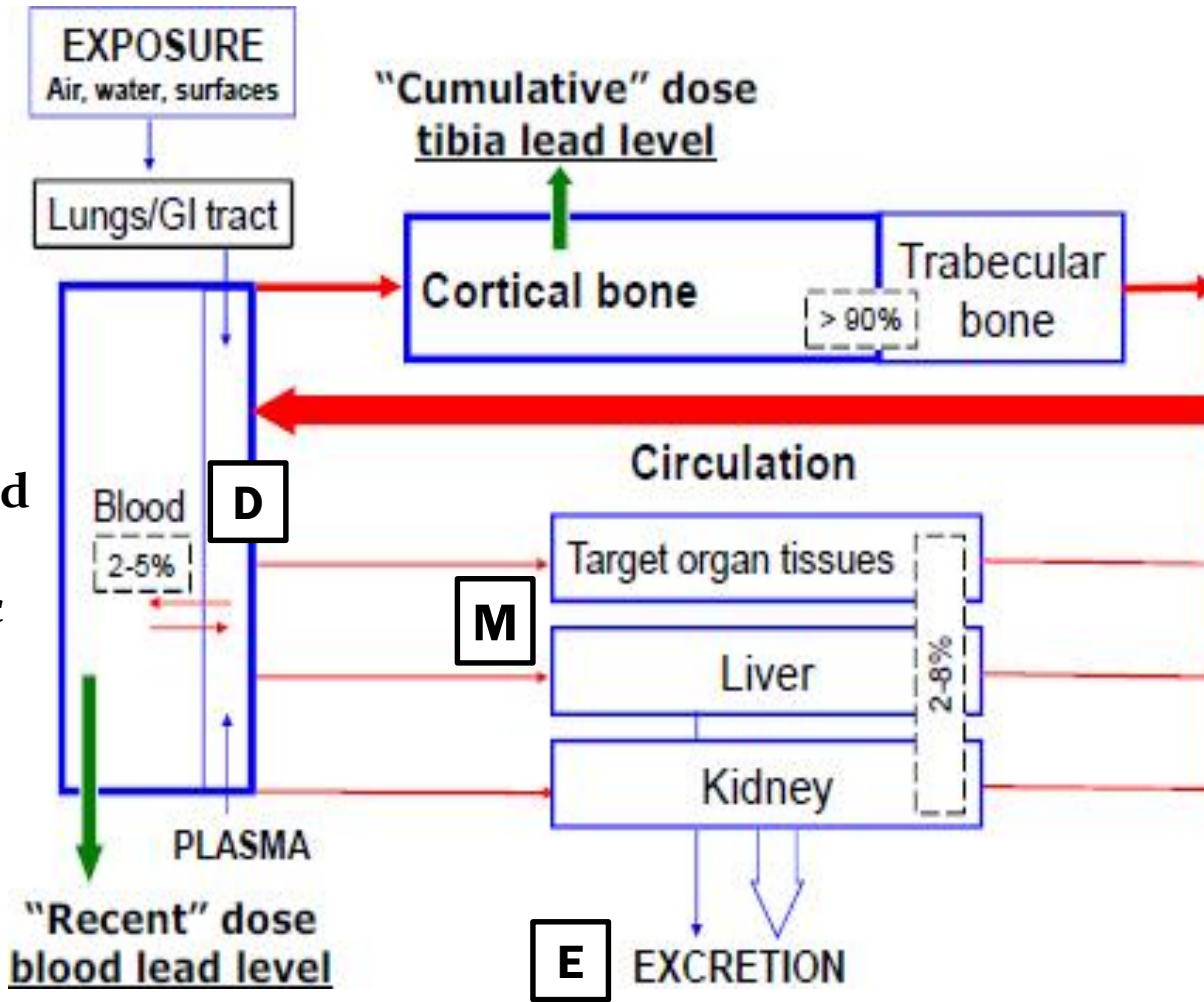
Gastrointestinal or pulmonary absorption

Pb enters the bloodstream

Distributed in the central and peripheral nervous, renal, reproductive, hematopoietic musculoskeletal, and other organ systems.

Excreted primarily in urine

A



Binds to sulfhydryl and carboxyl groups of proteins, thereby altering their structure or function

Toxicity

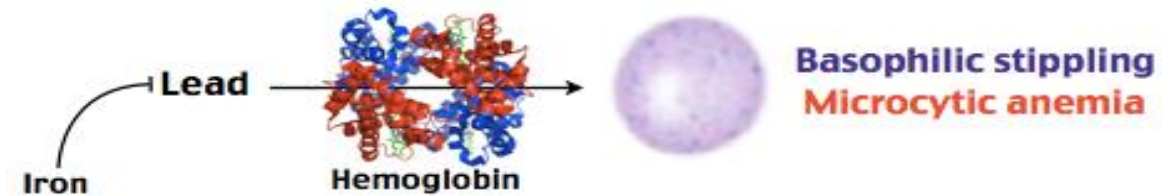
☠ *Neurological and Developmental Effects*

- Affect the brain by multiple mechanisms
 - Act as a surrogate for calcium and/or disrupt calcium homeostasis
 - A 2- to 4-point IQ deficit for each $\mu\text{g}/\text{dL}$ increase in BLL



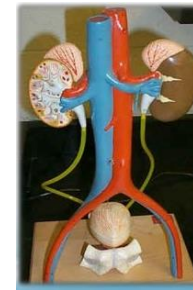
☠ *Hematologic Effects*

- Affect HEME synthesis by inhibition of ALAD activity



☠ *Renal Toxicity*

- Cause lead nephrotoxicity which lead to renal failure
- Often damage is not detected until it's too late





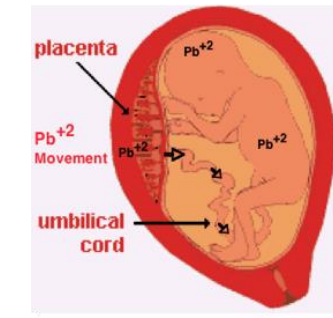
Adverse Health Effects of Lead Exposure

- ← 150 — Death
- ← 100 — Encephalopathy
- ← Nephropathy
- ← Frank Anemia
- ← Colic
- ← 50
- ← 40 — Decreased hemoglobin synthesis
- ← 30 — Increased vitamin D metabolism
- ← Increased risk of hypertension in adulthood
- ← 20 — Increased nerve conduction velocity
- ← Increased level of erythrocyte protoporphyrin
- ← Decreased vitamin D metabolism
- ← Decreased calcium homeostasis
- ← 10 — Developmental toxicity
- ← Delayed puberty
- ← Decreased growth & hearing
- ← 5 — Developmental toxicity
- ← Decreased IQ levels & academic abilities
- ← Attention-related behaviors
- ← Anti-social behaviors

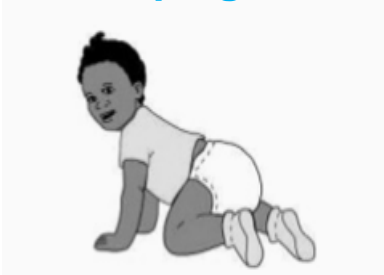
CDC reference level = 5µg/dL



Pregnant women

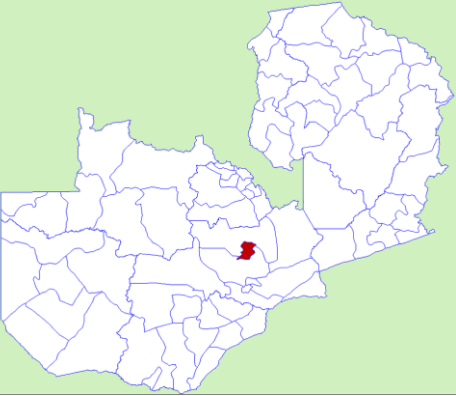


Developing fetus



Children

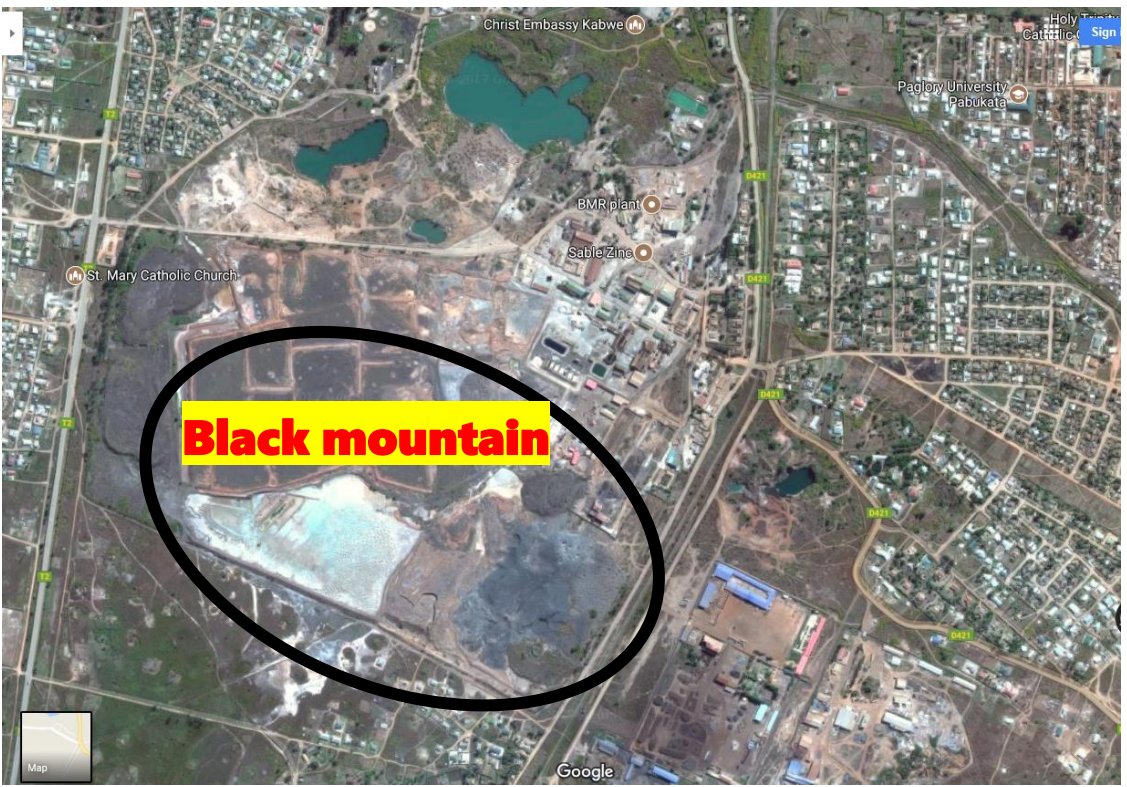




Kabwe ➤ Capital of Zambian Central Province
 ➤ 210,000 residents

➤ Long history of Pb-Zn mining; **from 1902 to 1994**

Kabwe town is:



KABWE IN TOP 10 MOST POLLUTED TOWNS
 POST ON: February 12, 2015



www.worstpolluted.org/projects



HOKKAIDO UNIVERSITY

Activities going on around the area...



Illegal miners scavenge for lead on Black Mountain



Children scavengers playing at lead contaminated soil



Women and children crush rocks to sell as gravel

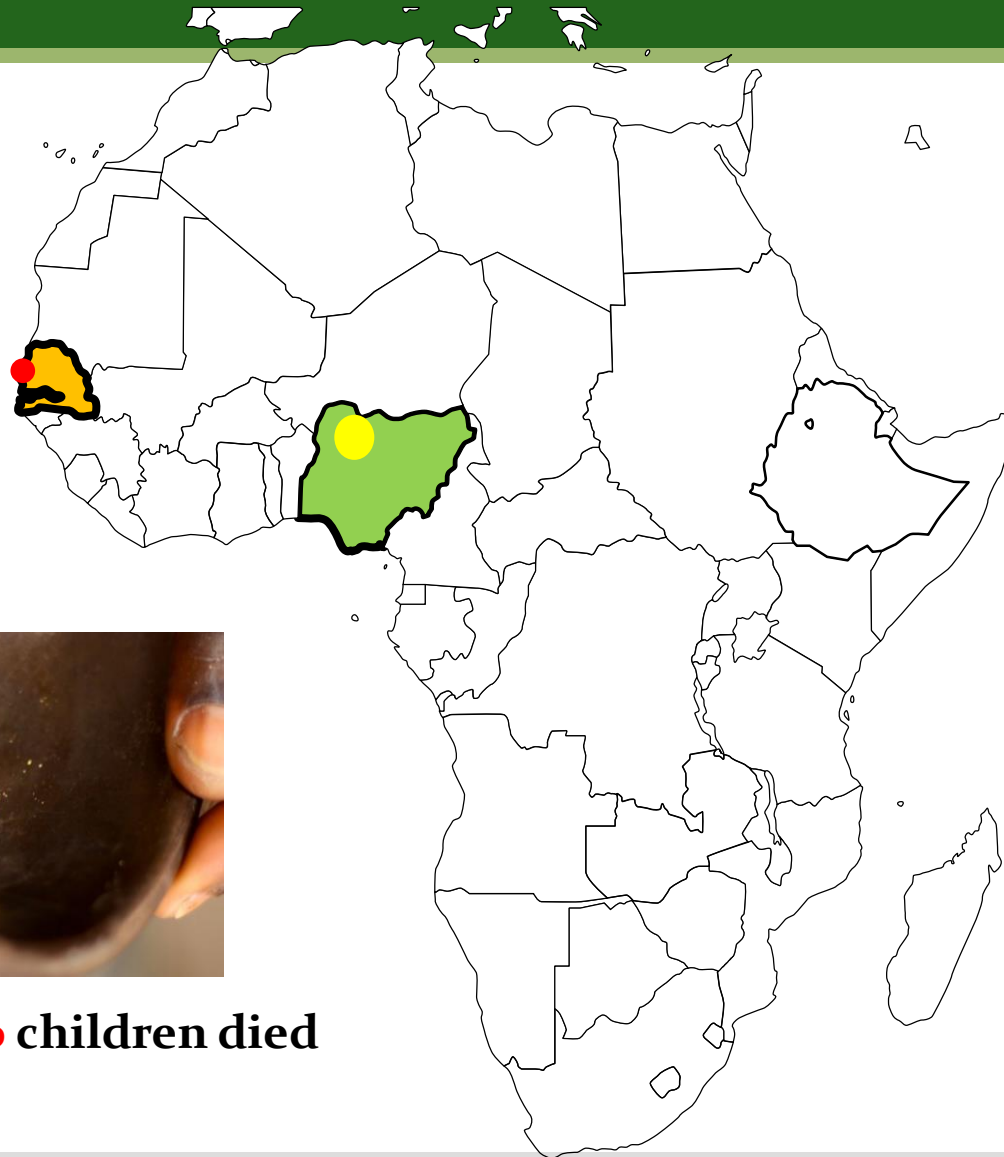
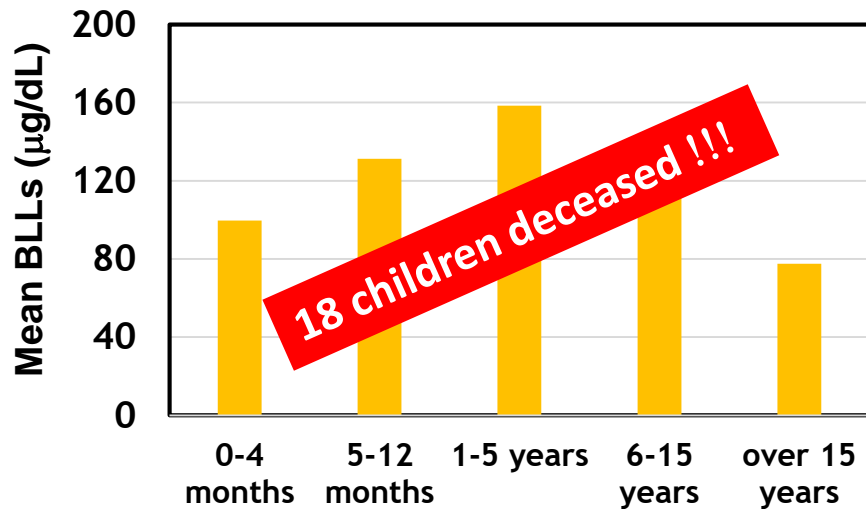


Over spill lead contaminated water

Dakar, Senegal

Mass Lead Intoxication from Used **Lead-Acid Battery Recycling** in Dakar, Senegal

EHP volume 117 (10), 2009



Zamfara, Nigeria

Massive Childhood Lead Poisoning

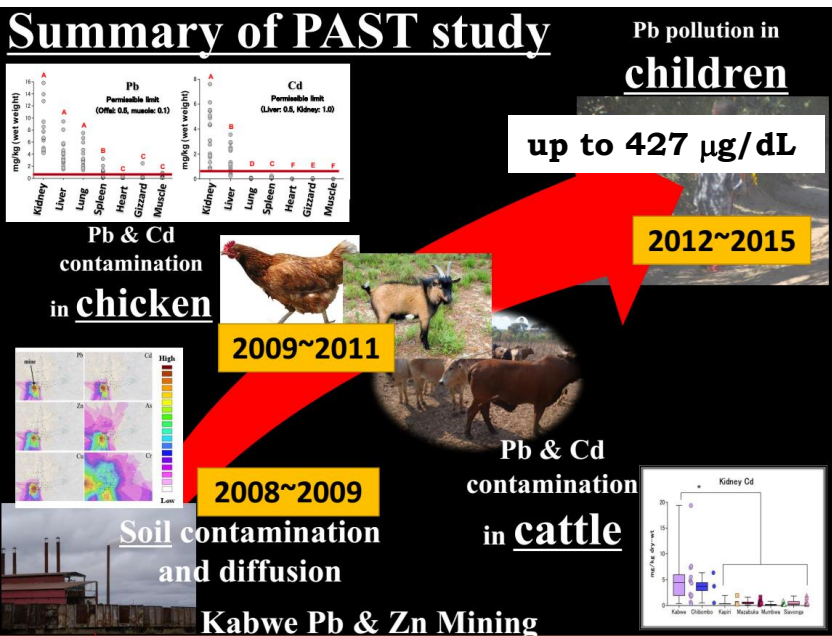
The Price of Nigerian Gold

Childhood lead poisoning on a scale unheard of for decades has been detected in rural northwestern Nigeria [EHP 120(4):601-607;



Going for GOLD, and killed by LEAD

2010: approximately **400** children died
2015: **27** children died



- It is known that the levels of lead in Kabwe soil is very high.
- Many children are with BLLs at critical and fatal levels.



There is no any proof of health effect..

- Many diseases either don't get recorded properly or are misreported.
- **There is no any epidemiological study to prove that lead is killing children in Kabwe.**

The health records are just not there.

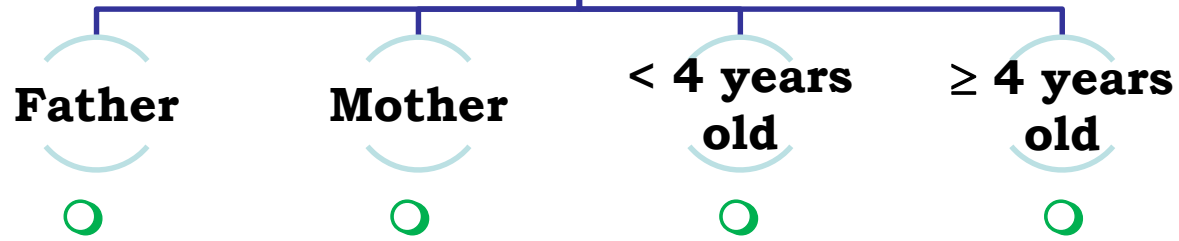
Objectives

- 👉 **Measuring the scope of lead contamination in Kabwe communities to characterize the city's burden of disease.**
- ✌️ **This in turn helps define interventions to mitigate exposures and alleviate adverse health outcomes.**

- ◆ **Blood**
- ◆ **Urine**
- ◆ **Fecal**
- ◆ **Breastmilk**

Big survey

1000 house holds

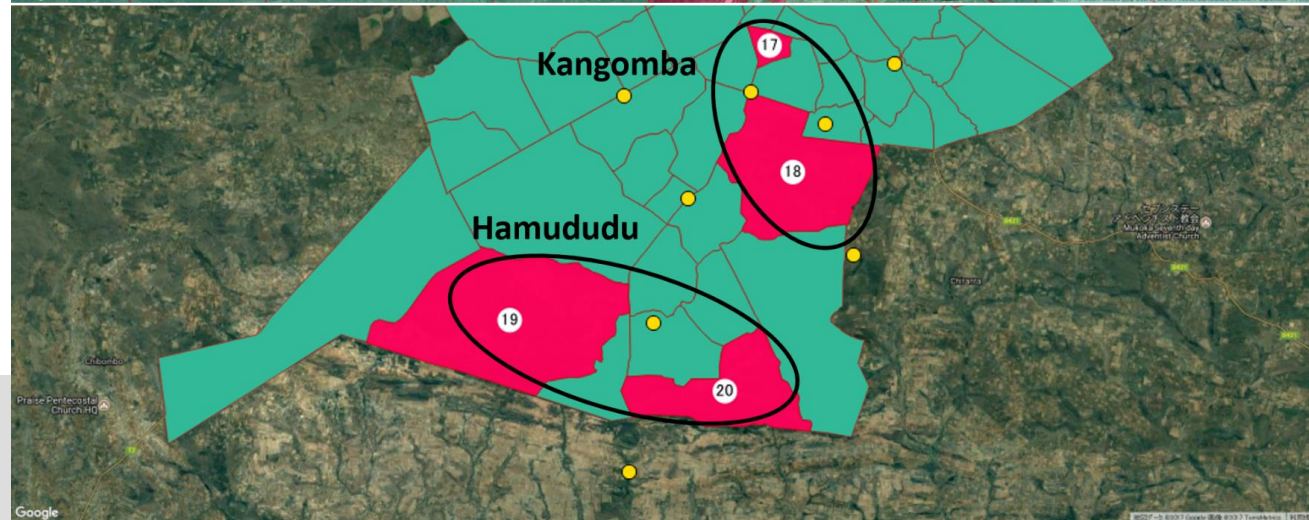
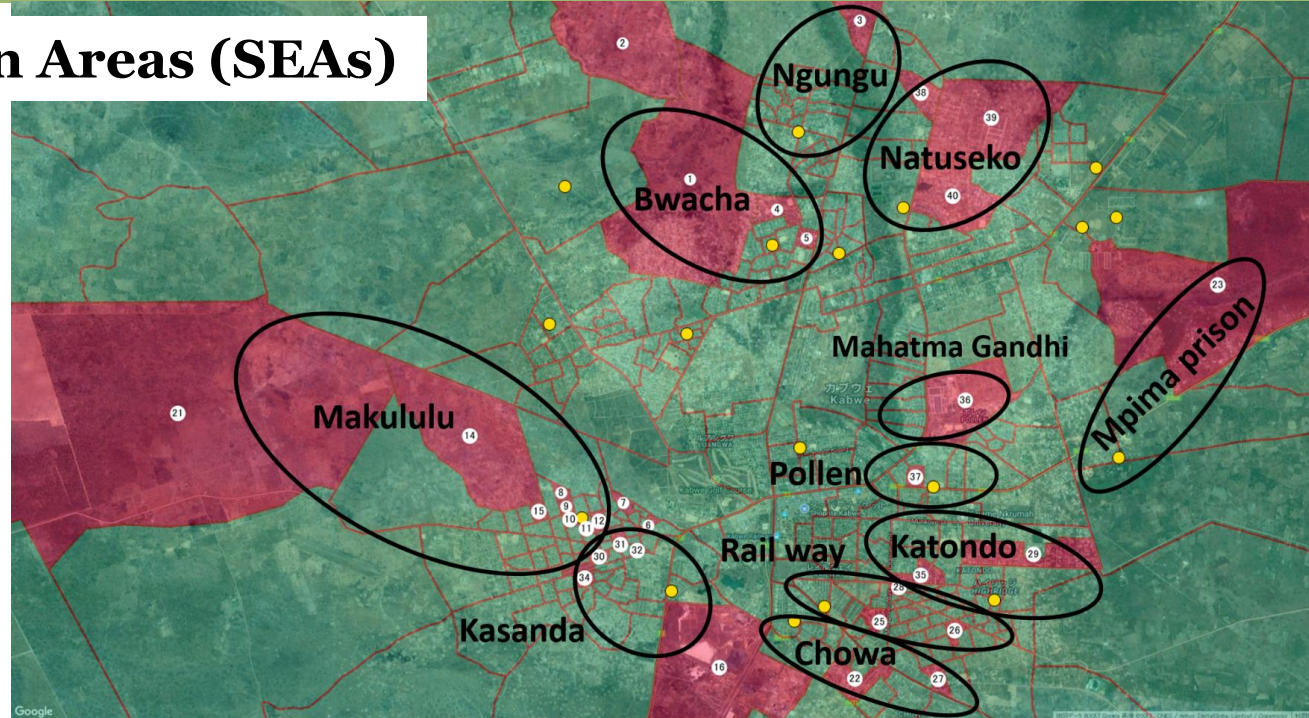


Human Risk assessment	○	○	○	○
Economical assessment	○	○	○	
Neurodevelopment		○		
Quality of life		○		
Intelligence activities				○



Sampling site

40 Standard Enumeration Areas (SEAs)



☼ Sampling & Analysis

Blood samples were collected from:

- ↪ 40 Standard Enumeration Areas (SEAs)
- ↪ 13 clinics
- ↪ About 1270 participants

	Father	Mother	Elder child	Younger child
N	217	421	323	309



Venous blood



Pb analysis

Collected at each health centers
by laboratory technicians



July-August, 2017

- Ethical clearance approved by MOH)
- Written informed consent obtained from parents

Possible ways of exposure



Dust emanating from the dump



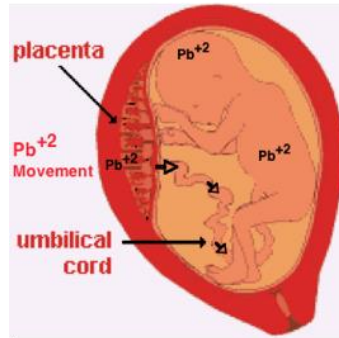
Illegal mining



Playing on lead contaminated soil



Pica



Placental transfer



Breast feeding

Courtesy - Larry C Price

Future perspectives...

1. Lead can pass the Brain Blood Barrier (BBB)

Pb

vs

Neurotoxic effect

2. Lead can pass to the placenta

Early exposure of Pb

vs

**Neurodevelopment &
Epigenetics**

3. Lead can inhibit the activity of different enzymes like the ALAD in our body

Environmental exposure of Pb

vs

Molecular & Biological effect



Acknowledgments

- Kabwe communities
- Children
- Families
- Zambia Ministry of Health
- Health centers
- Government offices



Flower

16



Zikomo

