Presentation from

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GROUNDWATER RESOURCES & CHALLENGES IN THE COPPER MINING INDUSTRY OF ZAMBIA .

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BACKGROUND

Zambia is a **stable and vibrant country** in Central Africa and is a natural hub for the diverse economic activities having a common boarder with **8 countries**.

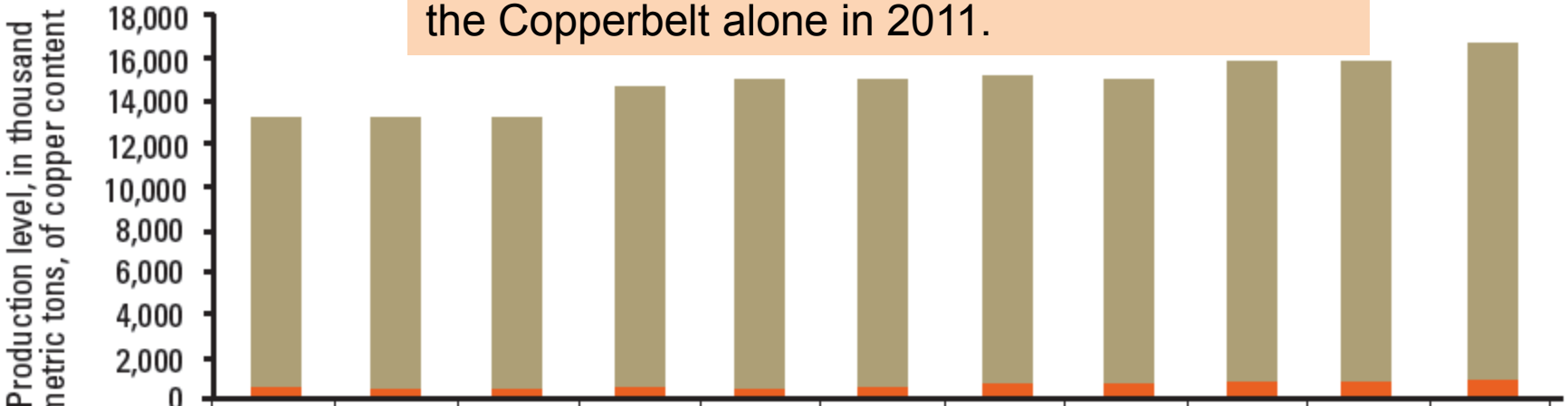
Geologically the country is favoured with an abundance of mineral resources and, in the late Proterozoic Lufilian terrain of north-western Zambia, boasts one of the world's most important and complex metallotects hosting enormous reserves of **copper-cobalt ore, together with gold, uranium, nickel, lead-zinc, iron and manganese**

Regional location of Zambia and transport network in central and southern Africa

Mining in Zambia

- The mining industry has been the economic and social backbone of Zambia since the 1930's.
- Since that time a wide spectrum of other metalliferous and non-metalliferous resources have been discovered in Zambia and, although exploitation of these has been limited.

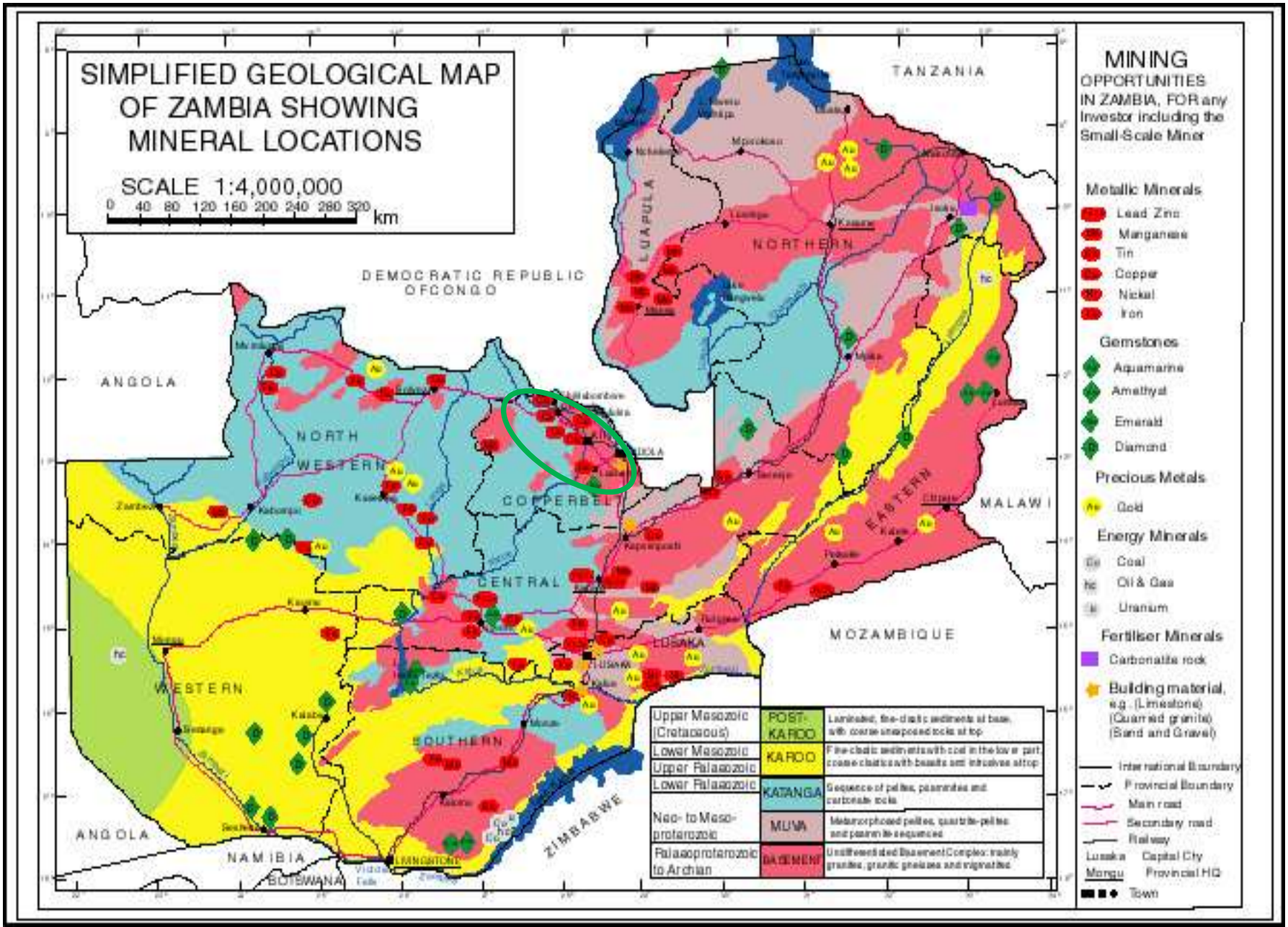
- A total mineral resource of at least 690 million tonnes of copper was estimated on the Copperbelt alone in 2011.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
World	13,700	13,700	13,700	14,700	15,000	15,100	15,500	15,400	15,900	15,900	16,100
Zambia	312	330	349	427	432	474	509	546	697	690	715

Sources: US Geological Survey, Mineral Commodity Summaries 2012; US Geological Survey Mineral Information — Zambia

Mining in Zambia



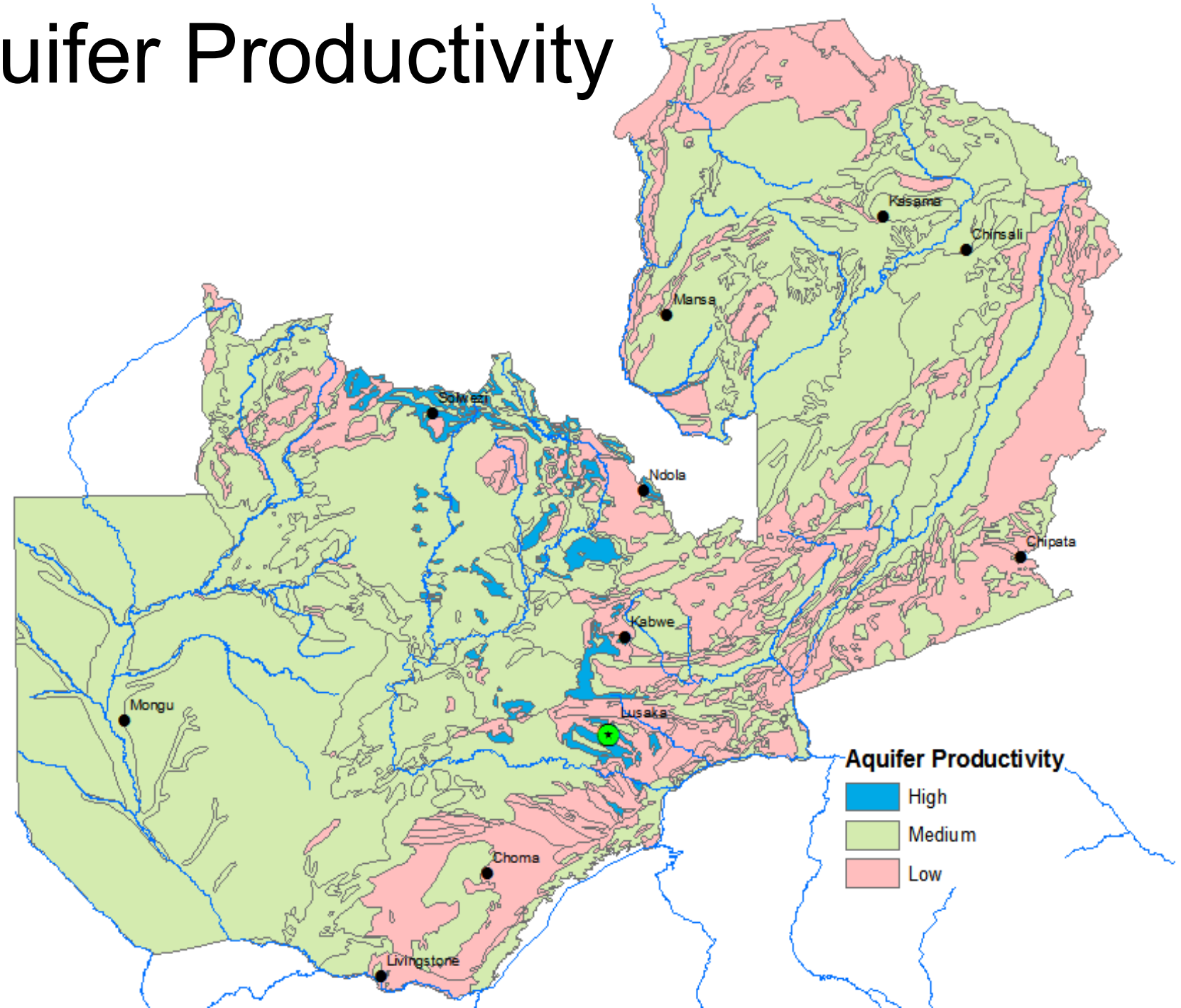
Aquifer Classification

Table 2.2: Classification of Aquifers

Lithostratigraphic Unit		Main Aquifer Lithology	Productivity of Groundwater	% of the Whole Country (%)
Cenozoic Supergroup	Alluvium	Sand, gravel	Medium-High	11.9
	Kalahari	Sand	Medium-High	23.8
Karoo Supergroup	Upper Karoo	Basalt	Low	0.5
		Sandstone	Medium-High	4.5
	Lower Karoo	Mudstone	Low	0.7
Katanga Supergroup	Kundelungu	Carbonate Rock	High	2.0
	Undifferential Kundelungu	Shale	Low	12.9
	Upper Roan	Dolomite	High	0.4
	Lower Roan	Quartzite, Dolomite	Medium-High	0.8
	Mine Series	Quartzite, Shale	Low-Medium	3.7
Muva Supergroup		Shale	Low	9.4
Basement Complex		Gneis, Migma-tites, Schist	Low-Medium	14.2
Granite		Granite	Low-Medium	15.2
Other Igneous Rocks		Basic-Igneous Meta-Igneous	Low	
Metamorphic Rocks		Metasediment, Metavolcanics	Low	

Source: Hydrogeological Map of Zambia (scale 1:1,500,000); Groundwater Resources Inventory of Zambia (Chenov, 1978).

Aquifer Productivity



GROUNDWATER CHALLENGES

- All mining practitioners are aware of water's dual nature: vital for many of the relevant processes and operations, but also a source of problems and major additional costs.
- Problems at a general level are because surface and underground workings occur below the water table.
- Immediate consequence is to drain the water from mining operations causing hydrological, environmental and economical problems calling for adequate management and administration of water.

Hydrological Challenges

- Mines require major drainages works and the associated flow rates and volumes fundamentally may depend on the characteristics of the aquifers (Transmissivity, size of fractures, hydraulic conductivity, thickness of protective layers, etc.), inputs of superficial waters and sudden in rushes from rainfall. These contributions are complex to ascertain.

Hydrological challenges…cont

- So, for example, high flow rate at Konkola Mine are from:
  - The presence of several aquifers stratigraphically above and below the ore strata
  - Potential recharge from precipitation and local surface streams, swamps, etc.;
  - Tension cracks associated with the Kirilabombwe Anticline which substantially increased permeability and storativativiy of strata and interconnectivy between aquifers

Hydrological challenges…cont

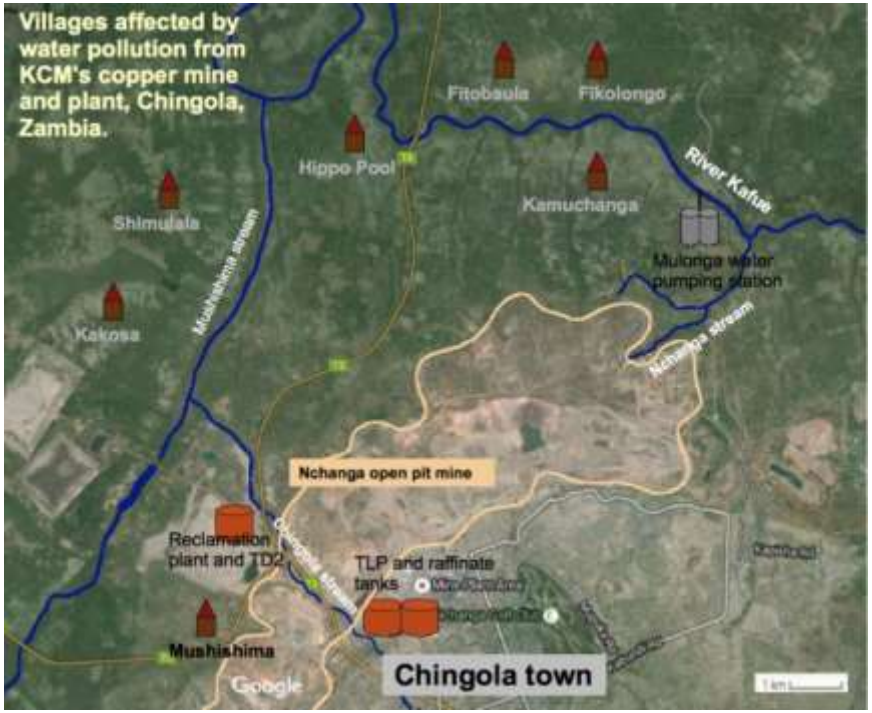
Konkola mine drainage is at 350,000 m^3/day and had peaked at 400,000 m^3/day in the 1980s. Ratio Water to Ore range 49:1 (Armstrong, 2014)

Environmental challenges

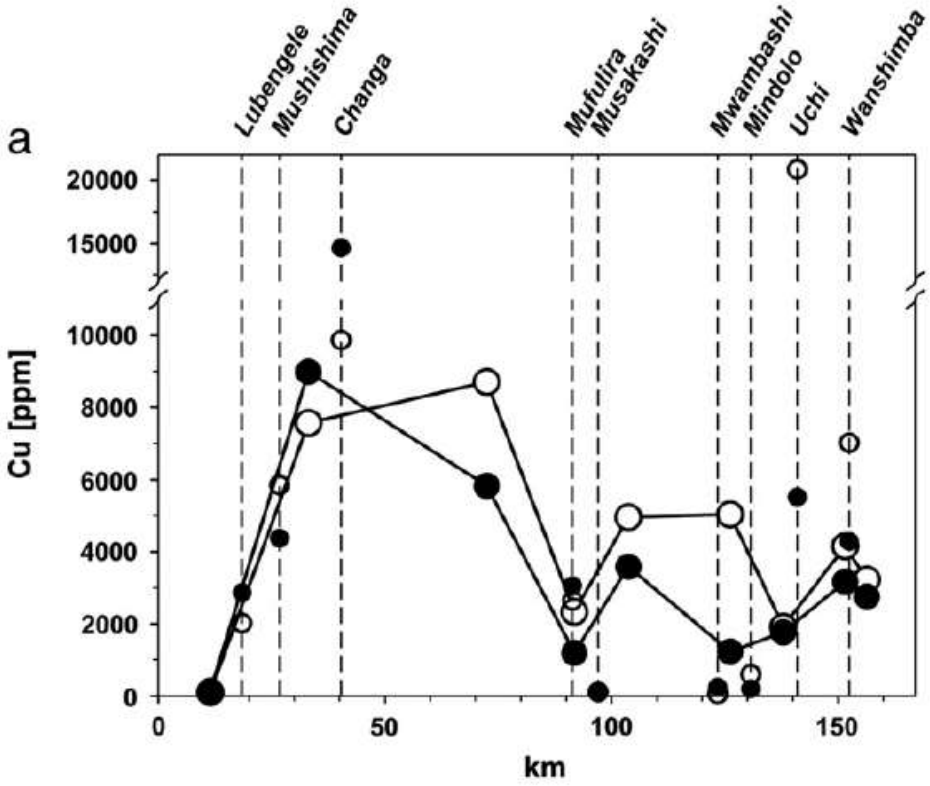
Nchanga Open pit, Copperbelt, Zambia

Cracking due to tremors caused by underground blasting and in some cases subsidence

SUBSIDENCE in the abondoned minor Nchanga Open pit, Chingola, Copperbelt



- Contamination of groundwater upon discharge (Copperbelt) and wetland depletion (esp. North-Western Province).



Sracek et al., 2012

Economic challenges

-E.g. KCM spends 10-15% on dewatering activities (IMWA, 1994) and probably much higher with recent power cuts.

Groundwater Management

- Zambia has now enacted the Water Resources Management Act, 2011 and moving in a process of implementation through S.I.
- Efforts towards aquifer characterization through focused projects in the Upper Kafue Basin such GReSP.
- Implementing programmes on optimal monitoring of water resources through a World Bank Project (Hydromet)

Groundwater Management..cont

- Development of groundwater resources database (GeoDIN)
- Capacity building activities (training techs on basic Hydrogeology….).
- Development of protocols/standards for data collection.
- Formation of support groups for drillers to aid data provision needs.

Thank You