

SOIL CONTAMINATION STUDIES AROUND THE BERG AUKAS ABANDONED MINE

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Geological Survey of Namibia (GSN)

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BACKGROUND

Berg Aukas is located 15km east of Grootfontein on the farm Berg Aukas 593, in the Otavi Mountain Land, Namibia

Berg Aukas is a **historical mining area**, where the Berg Aukas Zn-Pb-V deposit was discovered in 1913 (1920-1928 and 1950-1978)

- ❖ The Berg Aukas mine has been used as a Youth Vocational Training Centre agricultural vocational school and the farmland since the early 1990's by the Government of Namibia
- ❖ National Youth Service (NYS) uses most of the residential houses, workshops and hostels of the former mine
- ❖ The main activities are livestock and horticultural farming.
- ❖ Rainfall >500mm/a

Image © 2014 DigitalGlobe

Google earth

Imagery Date: 8/31/2012 19°30'53.96" S 18°15'25.36" E elev 4527 ft eye alt 14181 ft

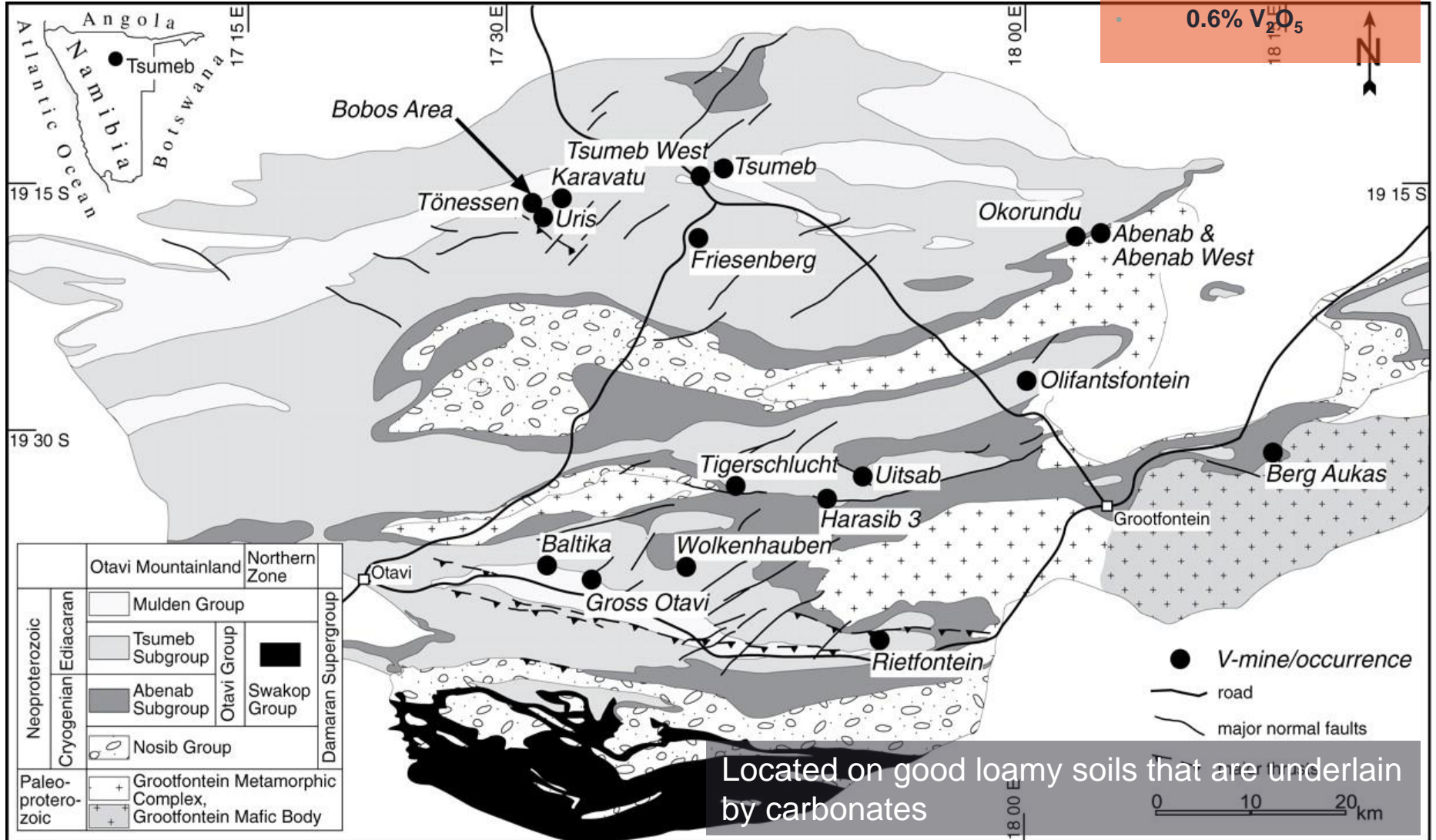
2219 ft

2002

Geology

❖ Overall production:

- 1.6 Mt of ore with
- 17% Zn,
- 5% Pb,
- 0.6% V_2O_5



Located on good loamy soils that are underlain by carbonates

Regional Geology of the Otavi Mountainland (Boni, 2007)

MINING REMNANTS



Aerial View of Berg Aukas Looking Northeast

Environmental Geochemical Survey

- ❖ Initial soil contamination studies conducted in this area commenced in 2007 by request of the Namibian Cabinet
- ❖ In 2013 the Berg Aukas area was revisited by the Division of Engineering and Environmental Geology (DEEG) to conduct a second soil sampling survey:

The purpose was to fill in data gaps; conduct a more detailed soil sampling survey that covered smaller intervals between the sample points giving a more ameliorates view on the extent of the contamination.

- ❖ Because of these land uses and the possible health risks, the studies aimed to help the local community to delineate no-go areas for agricultural use and to diversify the crops grown on contaminated soils to crops that are less vulnerable to high heavy metal contents in soils or transfer the crops grown on contaminated soils to areas that are not contaminated.

Methodology

- ❖ 230 and 156 surface soil in 2007 and 2013 respectively
- ❖ Approximately 0.5 kg of each soil sample was sieved to <2 mm upon
- ❖ A fraction of the <2 mm sample was sieved to $180\mu\text{m}$ and was then used for analyses
- ❖ Portable NITON XRF used in the analysis



Methodology...

- ❑ Since Namibia does not have guideline values for soil contamination, criteria from Canada, Germany and the Netherlands have been used.
- ❑ The guideline values refer to the acceptable concentration for the intended use of a particular site.

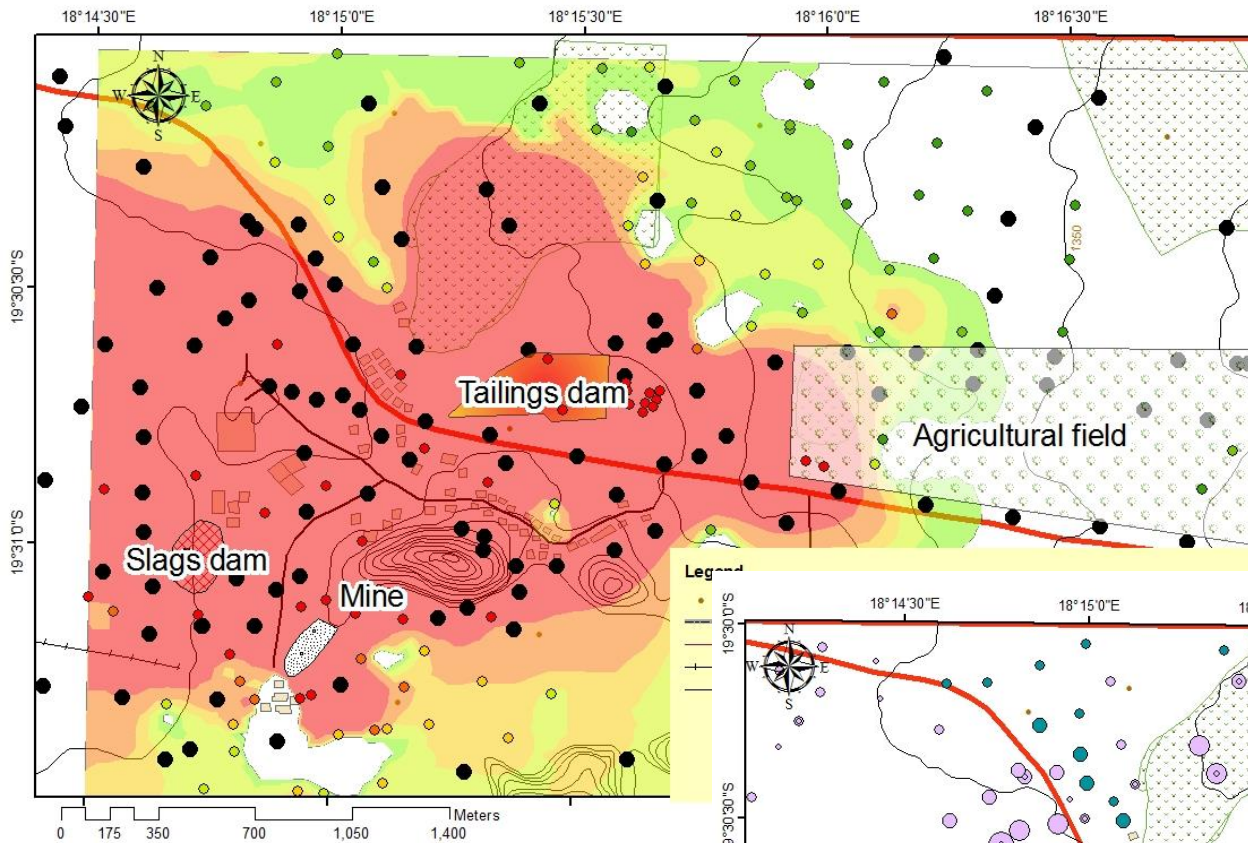
Table x: Canadian clean up criteria for contaminated sites

	Agriculture	Commercial land use	Industry	Units
As	12	12	12	ppm
Cd	1.4	22	22	ppm
Cu	63	91	91	ppm
Mo	5	40	40	ppm
Pb	70	260	600	ppm
Zn	200	360	360	ppm

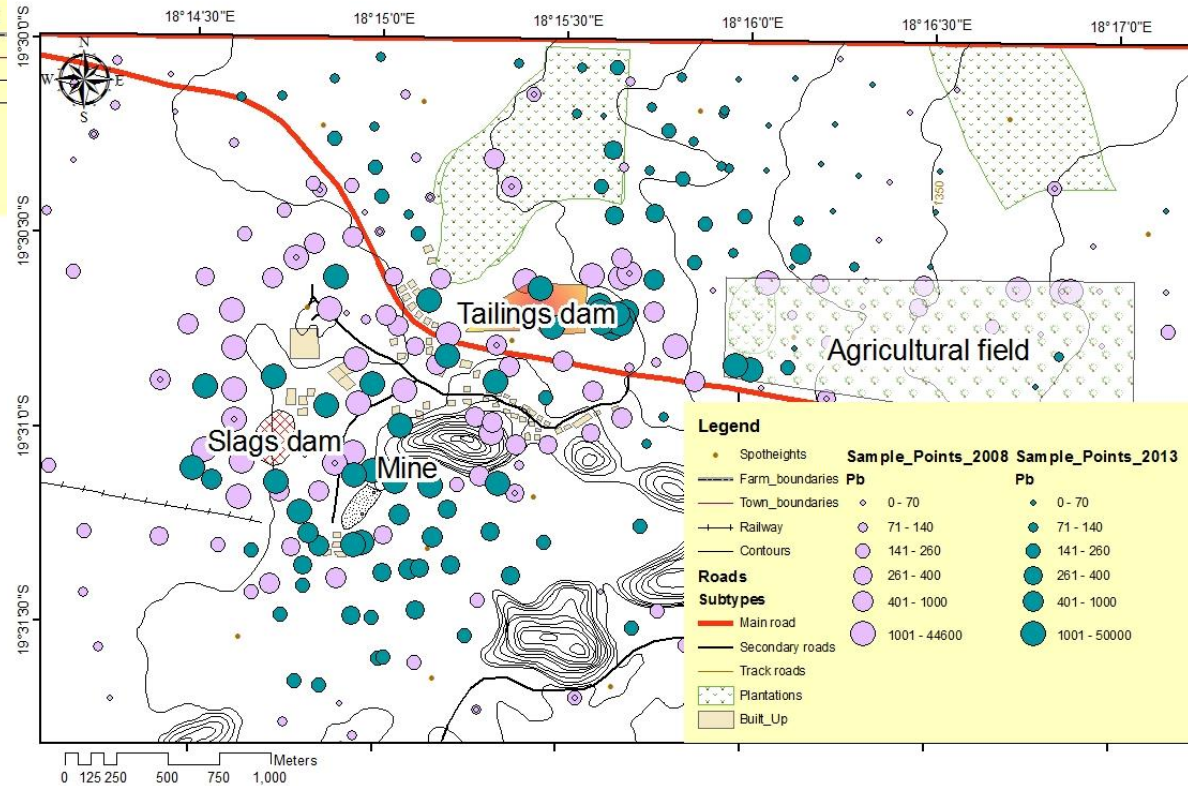
RESULTS

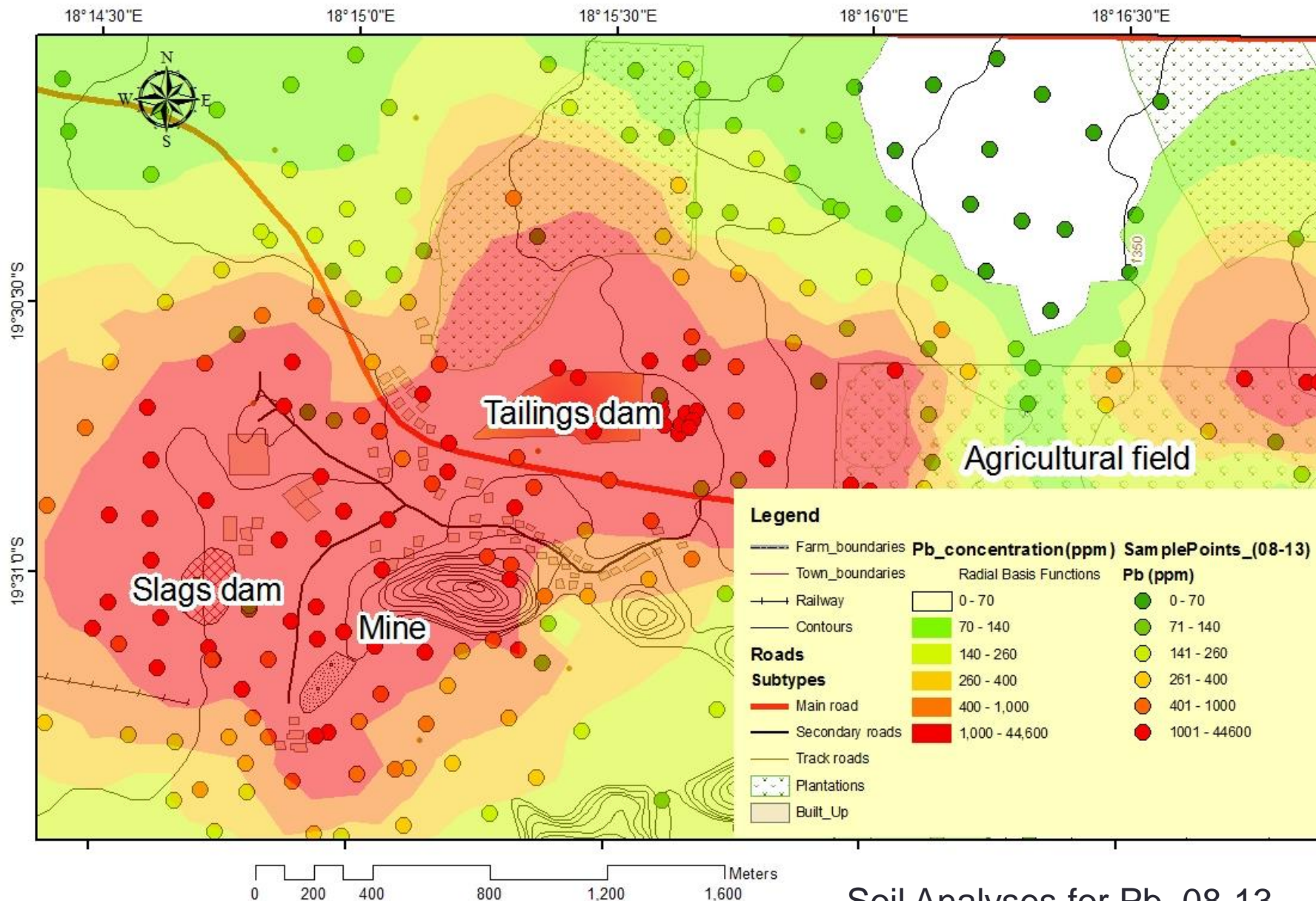
The main pollutants were found to be metals like Lead (Pb), Zinc (Zn), Vanadium (V), Copper (Cu), Cadmium (Cd) and Arsenic (As).

Soil Analyses for Pb (2013)

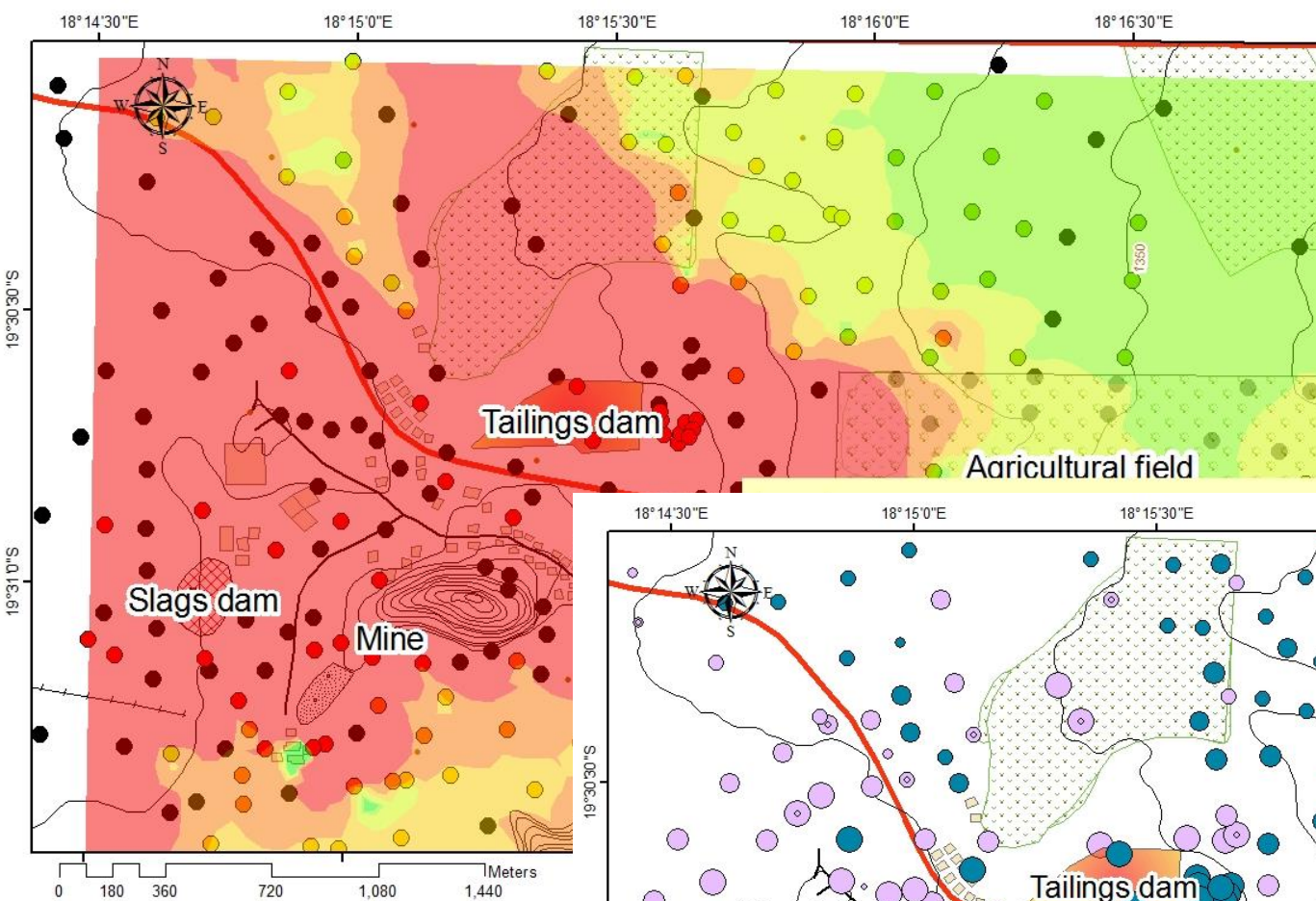


Soil Analyses for Pb_08-13 (high values in the area are located in heavily contaminated areas (area of mining and metallurgical complex and area downwind of tailing deposits))

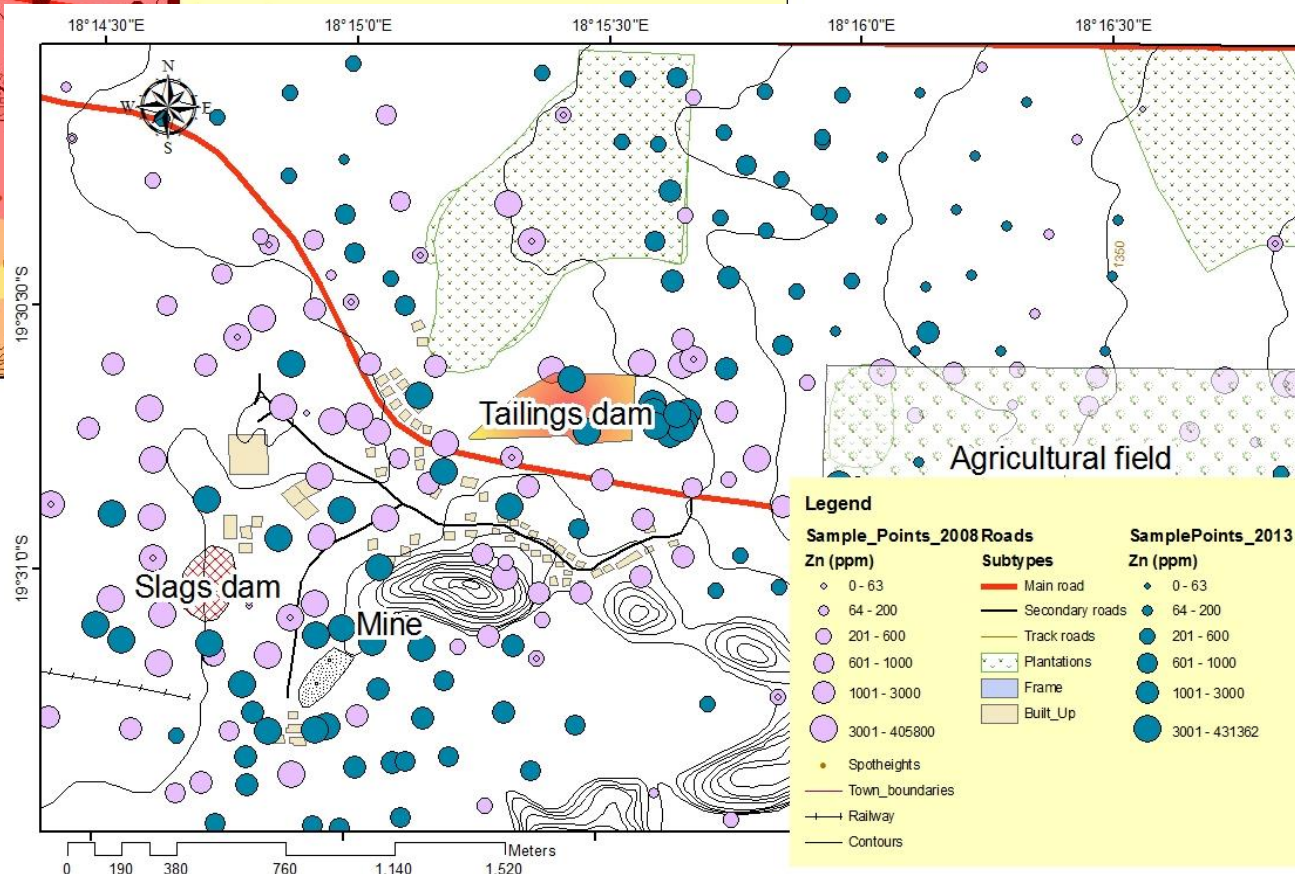




Soil Analyses for Pb_08-13



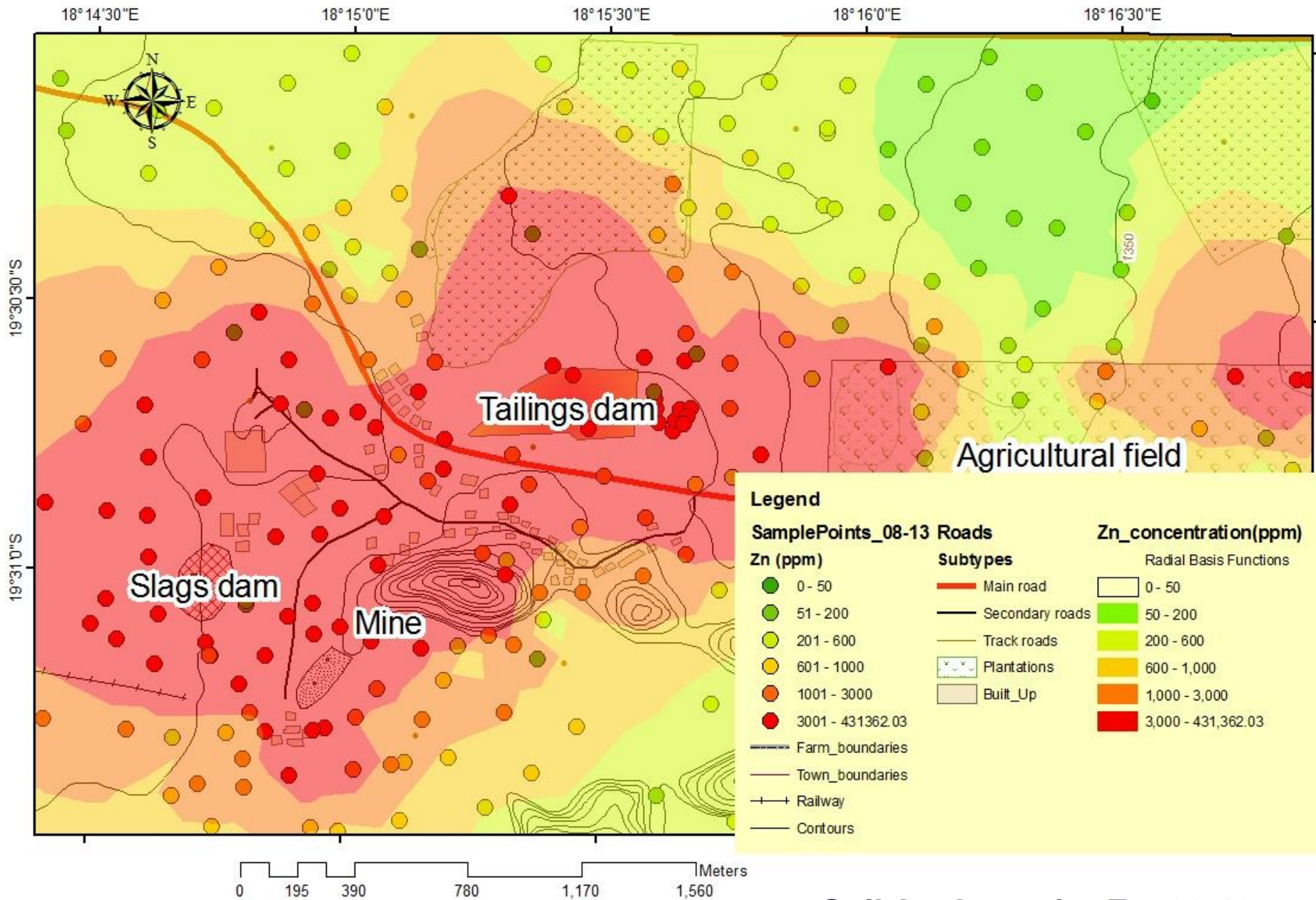
Soil Analyses for Zn_2013



High values occur in the area of the former mining and processing complex and eastward (down-wind) of the tailing and slag dams.

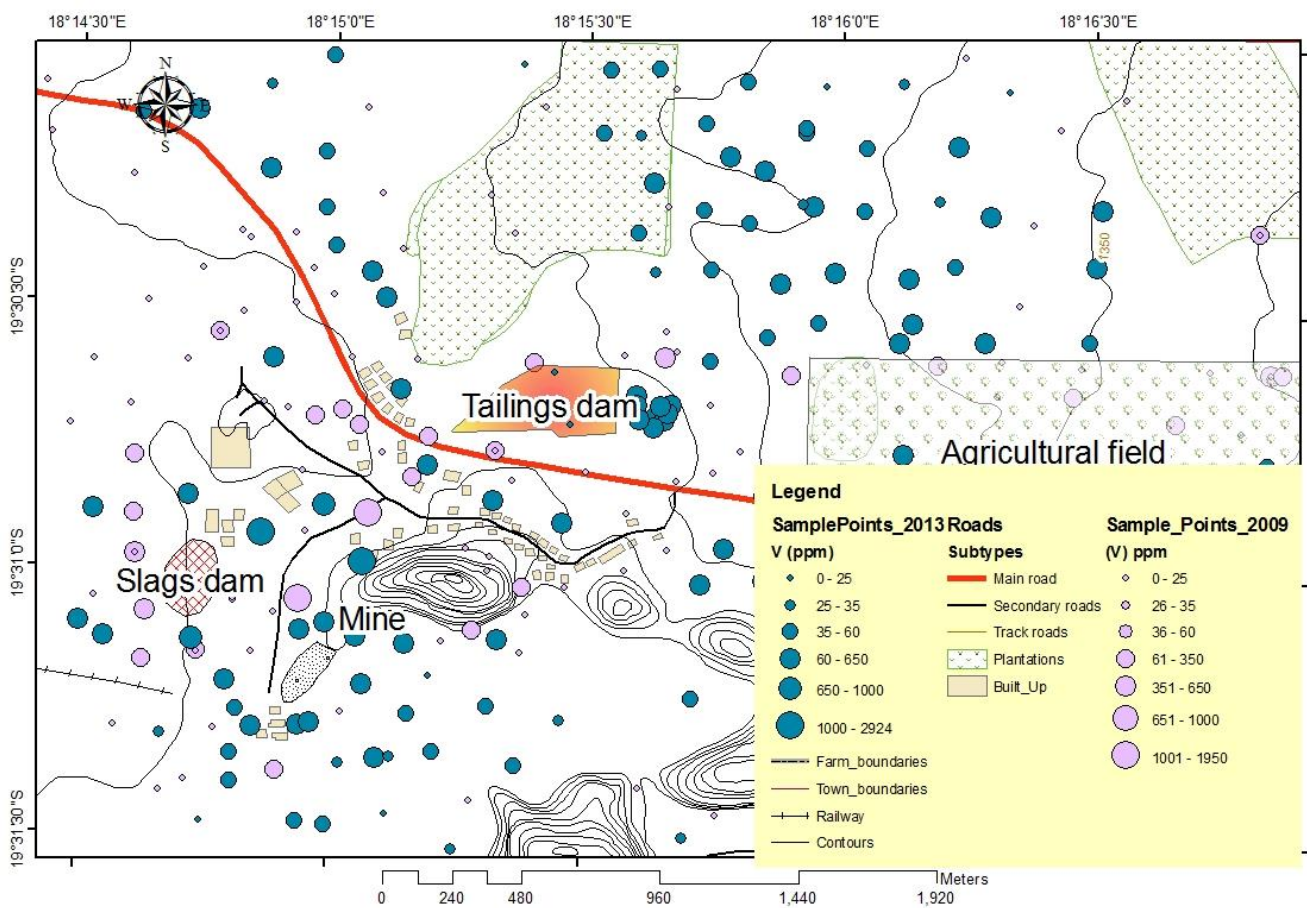
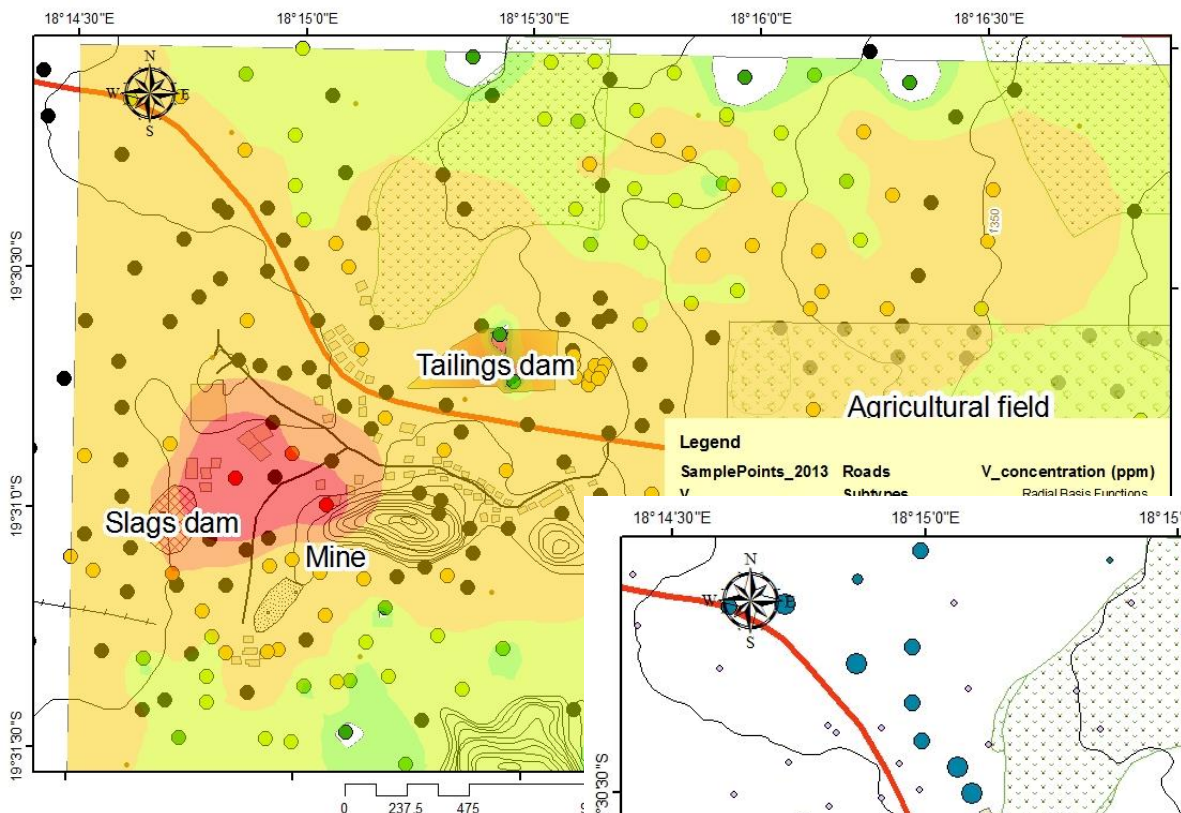
Legend

Sample_Points_2008 Zn (ppm)	Subtypes	SamplePoints_2013 Zn (ppm)
0 - 63	Main road	0 - 63
64 - 200	Secondary roads	64 - 200
201 - 600	Track roads	201 - 600
601 - 1000	Plantations	601 - 1000
1001 - 3000	Frame	1001 - 3000
3001 - 405800	Built_Up	3001 - 431362
Spotlights		
Town_boundaries		
Railway		
Contours		



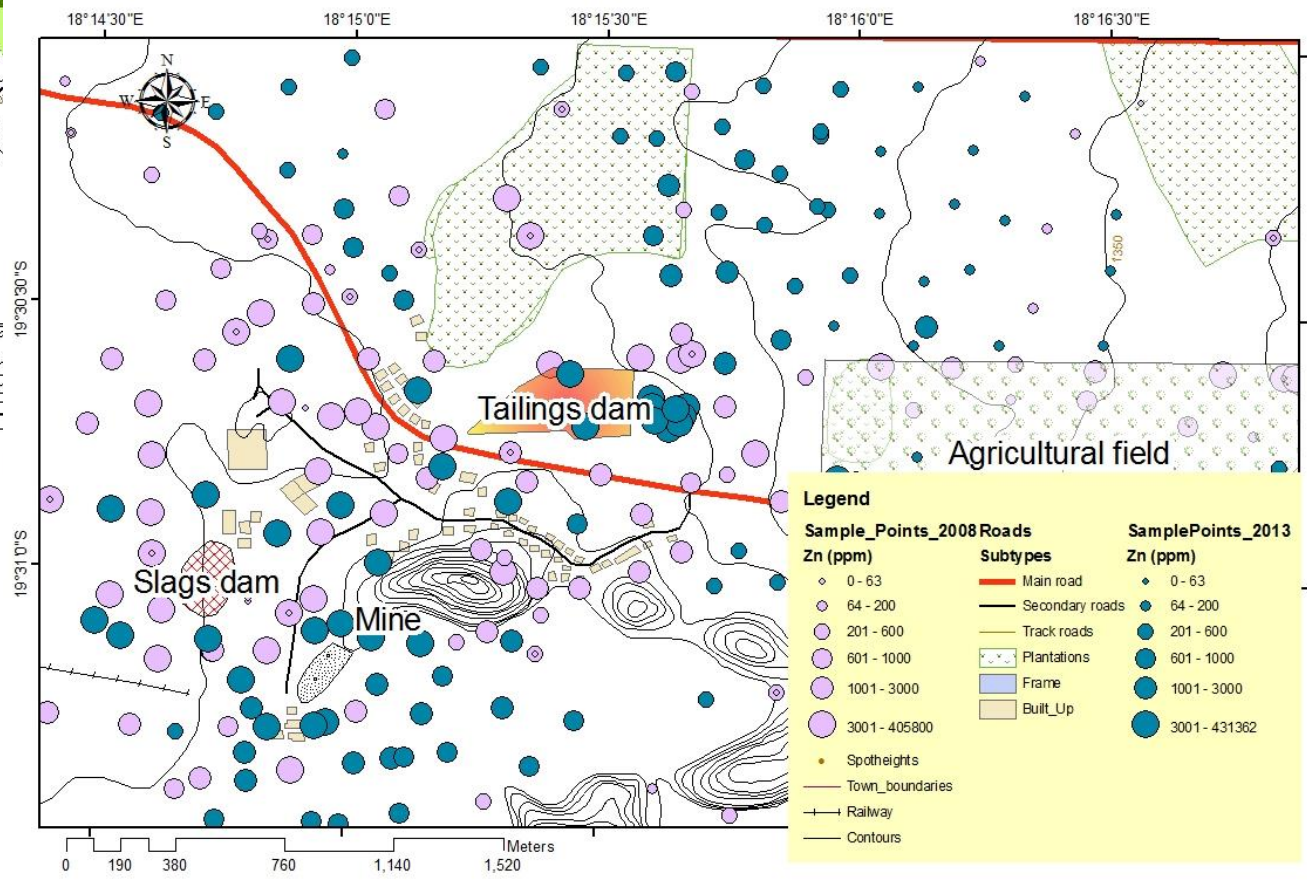
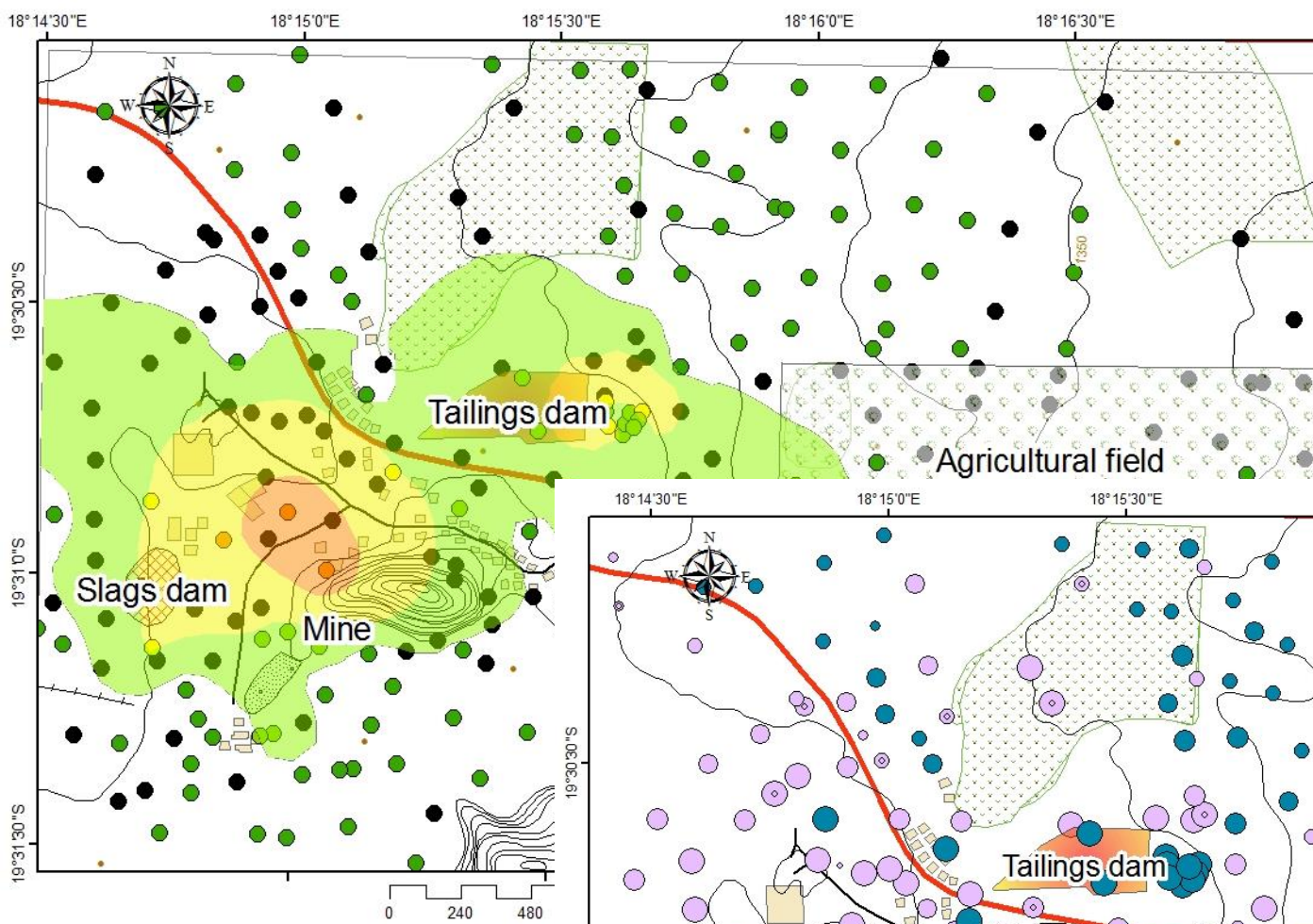
Soil Analyses for Zn_08-13

Soil Analyses for V_2013



Analytical Results for Berg Aukas for V (08-13). Showing the correlation between the old and new results.

Soil Analyses for Cu_2013



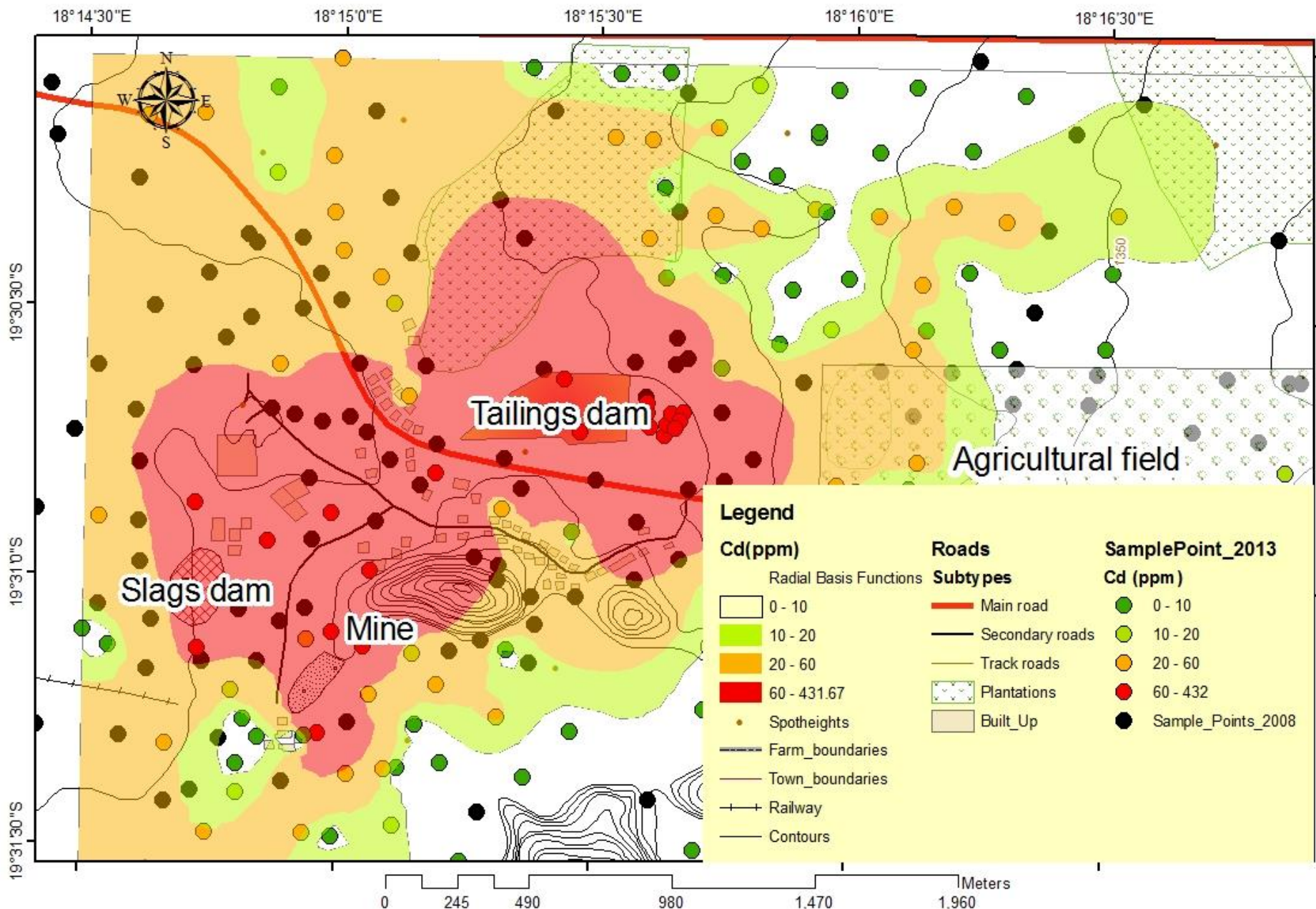
Legend

Sample_Points_2008		SamplePoints_2013	
Zn (ppm)		Zn (ppm)	
○	0 - 63	●	0 - 63
○	64 - 200	●	64 - 200
○	201 - 600	●	201 - 600
○	601 - 1000	●	601 - 1000
○	1001 - 3000	●	1001 - 3000
○	3001 - 405800	●	3001 - 431362

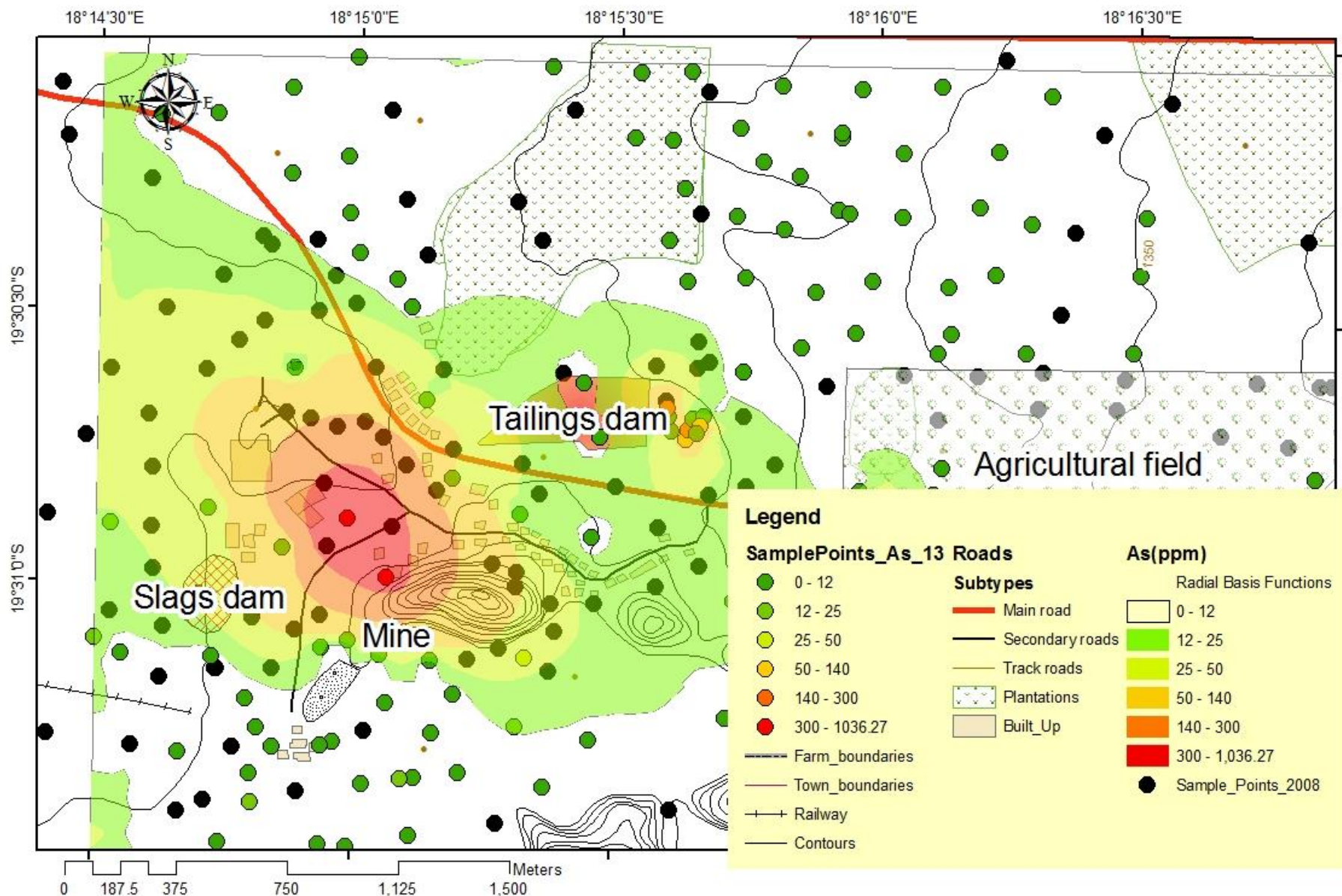
Roads		Subtypes	
—	Main road	—	Main road
—	Secondary roads	—	Track roads
—	Track roads	▨	Plantations
▨	Plantations	▨	Frame
▨	Frame	▨	Built_Up
▨	Built_Up		

●	Spotheights
—	Town_boundaries
+	Railway
—	Contours

Analytical results of Cu for Berg Aukas (08-13)



Soil Analyses for Cd_2013



2013 Soil analyses showing high arsenic values North of the old mine and East of the tailings dams

Recommendations...

PREVENTING ADDITIONAL CONTAMINATION

- ❑ Prevent wind erosion from the smelter site and slag dump by soil and vegetation coverage
- ❑ Prevent further spilling of tailings material into the agricultural area by spillage control

Recommendations...

FARMING

- ❑ The major part of the agricultural fields is suitable for crop farming
- ❑ Cease crop production up to 1.8 km to the east of the tailings dump (slikdam) northeast of Berg Aukas.
- ❑ Avoid growing of potatoes, melons, pumpkins and root vegetables, in the moderately contaminated areas.
- ❑ Change crops to less vulnerable types like maize and stem vegetables (tomato, pepper) in the moderately contaminated areas.
- ❑ Restrict growing of root vegetables and limit crop farming in the settlement.

Recommendations...

INFRASTRUCTURAL MEASURES

- ❑ Any new development (industry, residential, agricultural) has to be avoided in red zones

TRIGGER REMEDIATION

- ❑ Contaminated urban areas have to be rehabilitated, if they are intended for future use as residential areas, e.g. by covering top soils with organic matter and vegetation.
- ❑ Removal of the severely contaminated top soil seems an option in some parts of the settlement, which are affected by airborne pollution. Here, the highly contaminated top soil can be removed and properly disposed
- ❑ Soil removal and re-disposal is not an option in the central processing and smelting zone due to a deep penetration of the contaminants in the soil horizon, and thus, a tremendous volume of contaminated soil. Rehabilitation by reprocessing of the extremely contaminated soil (3% Pb, 30 % Zn) might be viable

Conclusion

- ❑ The study shows that most parts of Berg Aukas are severely contaminated with lead, zinc, vanadium, cadmium and arsenic
- ❑ The large-scale contamination of the whole Berg Aukas area can be attributed to the roasting of ores in the past and by dust fallout from slimes dams and slag deposit.
- ❑ The Government of Namibia reacted without delay on the results of this study and Cabinet decided to take immediate action by evacuation of the hostels of the vocational school.
- ❑ Students are now accommodated in a safe environment at Rietfontein near Grootfontein.
- ❑ The Division of Engineering and Environmental Geology is going to conduct further studies in the Berg Aukas Area

A photograph of two young boys playing soccer on a dirt field. The boy on the left is wearing a red tank top and khaki shorts, running towards the right. The boy on the right is wearing a blue tank top and green pants, kicking a yellow ball. In the background, there is a yellow building with a white roof and a tree. The scene is brightly lit, suggesting a sunny day.

**THANK YOU
FOR YOUR ATTENTION**

OKUHEPA

Soil is the human pathway