

Acidity Health and the Environment

**Acid Sulphate Soils Disturbance,
Heavy metals and Human
Exposure - Preliminary
Investigations**

**Dr Andrea Hinwood
Centre for Ecosystem Management**

**Funded by ECU Faculty Small Grant , WA Department of Environment,
Consortium for Health and Ecology ECU**

Acknowledgements

- Residents in the Stirling/Gwelup Lakes Area
- Caroline Barton
- Ruth Rogan
- Ashley Wilmott
- Wesu Ndilila
- Heather McQueen
- Pierre Horwitz

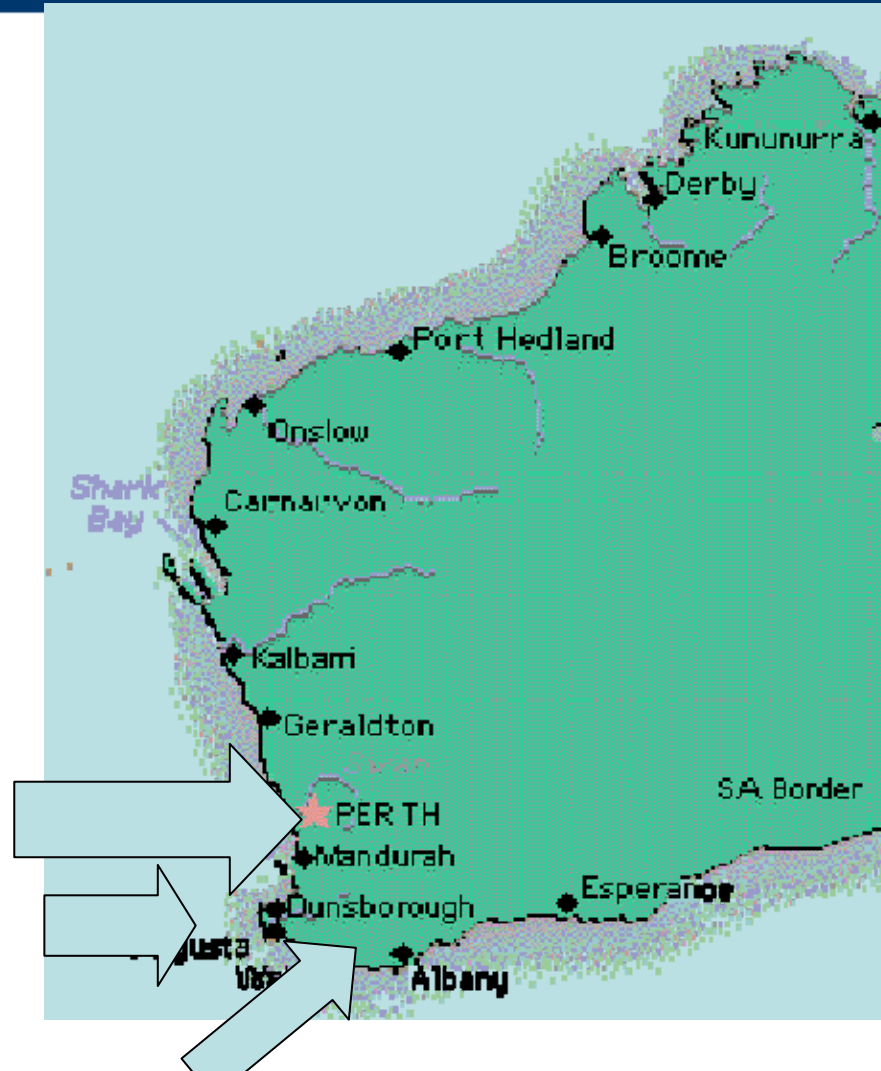
Background

- Urban growth in low-lying, swampy land released for new housing estates.
- Development involves lowering of the ground watertable to allow peaty soils, to be dewatered and excavated and replaced with sandy fill.
- Decline in groundwater levels with lower rainfall
- Presence of acid sulphate soils, formation of acid, mobilisation of metals.

Areas affected by ASS

****Approx 70% Perth's populations relies on Groundwater

ASS Affected Areas





04_02_3.JPG



04_02_10.JPG



04_02_2.JPG



04_02_11.JPG



04_02_13.JPG

Background cont-

- Very high concentrations of metals found in residential bore water up to 6600ug/L As.
- Anecdotal information indicating substantial use of bore water for irrigation of garden, home grown produce and filling swimming pools.
- Risk of increased human exposure to metals via ingestion of potentially contaminated produce.



What do we know about metals and uptake by produce?

- The concentration of metals in produce irrigated with contaminated water and/or grown in contaminated soil varies considerably.
- Uptake is influenced by the chemistry where the more acidic the environment, the greater the uptake of heavy metals (Bensryd et al., 1994).
- Exposure will depend on the type of produce, application of contaminated water, the concentration of metals and the amount consumed

Health effects of exposure to metals

- Health impacts of arsenic and dietary intake of arsenic in settings with very high concentrations well established.
- Health effects of Cd and Pb also well established but unknown in the setting described.
- Risks for the young and elderly may be significant.

Aims of this preliminary Investigation

The main aims of this research were to:

1. Establish characteristic concentration ranges of metals in groundwater known to be impacted by acid sulphate soil disturbance.
2. Establish patterns of domestic use of the groundwater, in particular its application in growing food.
3. Measure human exposure using both environmental and biological measures

Part 1 Establishing Concentration Ranges of Metals

- A cross sectional study of bore water users in Stirling Lakes area
- Recruited 67 households in two target areas September to November 2004
- Participants recruited via doorknocking (low recruitment rate of 20%).
- Participants asked to provide samples of bore water and answer questions on use of the water.

Concentration of metals in bore water of residents (mg/L).

Parameter	N	Mean	Min	Max	% samples less than DL	% samples exceeding Drinking Water or Recreational water quality guideline values	Drinking water guideline mg/L*	Recreational Water quality Guidelines mg/L**
Aluminium	65	1.4	DL (<0.005)	37.0	66.7	27.3	0.2	0.2
Arsenic	65 19	0.10 0.005	DL (<0.05) DL(<0.0001	6.6 0.025	79.3 31.6	8.6 26.3	0.007	0.05
Iron	65	31.5	DL	1200	25.4	74.6	0.3	0.3
Selenium	65 20	<0.05 0.002	DL (<0.05) DL (<0.001)	<0.05 0.006	100 35	0 0	0.01	0.01
Cadmium	20	0.001	DL (<0.002)	0.021	88.2	11.8	0.002	0.005
Chloride	65	137	73.0	257	0	0.02	250	400
Lead	20	0.008	DL (<0.005)	0.040	60.0	29.9	0.01	0.05
Mercury	20	<0.005	DL (<0.005)	<0.005	100	0	0.001	0.001
Sulphate	65	237	2.4	4047	0	21.5	250	400

Some Conclusions

- High bore ownership (79.5%)
- Elevated metals concentrations (Al, As, Cd, Pb) in approx 30% of the population sampled (note low recruitment rate for study)
- High percentage growing produce 90%
- High percentage of consumption 88%
- Potential population affected in the order of 15,000 people, in areas like Innaloo, included -27,000

Part 2 - Human exposure preliminary investigation

A cross sectional study of human exposure in ASS affected area.

The study aimed to recruit 50 residents (30 residents known to be using bore water and 20 residents not using bore water).

27 Participants, 21 using bore water, 6 non bore water users.

Recruitment rate 7%

Part 2 - Human exposure preliminary investigation

- Each participant asked to provide a:
 - first morning void urine sample,
 - a sample of toenails from all ten toes,
 - a sample of hair from nape of neck, and
 - a sample of bore water
- Self administered questionnaire asking about use of bore water and other factors that may influence exposure.
- Descriptive analysis of data only.

Bore Water Concentrations

- Water metal concentrations were lower than previous investigations with minimum and maximum concentrations (mg/L) as follows;

• pH	n=19	4.09 - 7.14
• Aluminium	n=19	<0.5 - 9000ug/L
• Arsenic	n=19	<0.5 - 3.00ug/L
• cadmium	n=19	<0.1 - 7.10
• Lead	n=19	<0.1- 13.0

Findings

- Home grown produce consumed by 71% of participants
- Up to 83% consume the produce grown
- All wash their fruit and veges
- 61% of bore water users used the water every day
- High % of gardeners
- Higher percentage of smokers in non bore water use group 23% in bore water users

Results

Hair metal concentrations for participants using bore water and those not reporting use of bore water (mg/kg).

	Al-Hair	As-Hair	Cd-Hair	Pb-Hair	Cu-Hair	Zn-Hair
Exposed						
n	17	17	17	17	17	17
Median	5.5	0.001	0.130	0.99	41.0	170
Mean	8.39	0.008	0.18	1.30	54.0	168
Range	<DL-38.0	<DL-0.07	0.02-0.57	0.19-4.30	11.0-160	99-280
SD	9.41	0.02	0.15	1.14	41.9	46.4
Unexposed						
n	5	5	5	5	5	5
Median	5.7	0.001	0.060	0.68	30.0	150
Mean	5.44	0.0168	0.009	0.71	57.6	160
Range	2.9-8	0.001-0.08	0.05-0.22	0.35-1.3	28.0-150	140-210
SD	2.4	0.035	0.090	0.37	52.5	29.2

Results

- Urinary metals concentrations low and no difference between bore water users and non users
- Metals concentrations in toenails higher in non bore water users reflective of soil concentrations
- Hair concentrations higher in bore water users than non users for Al, Cd, Pb and Cu
- Participants using bore water 4-5 times per week, higher hair concentrations than lower frequency use.

Results

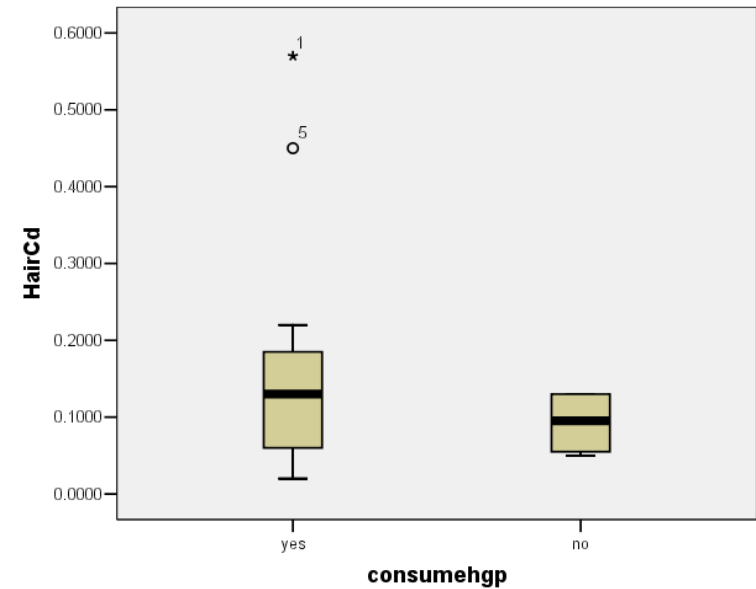
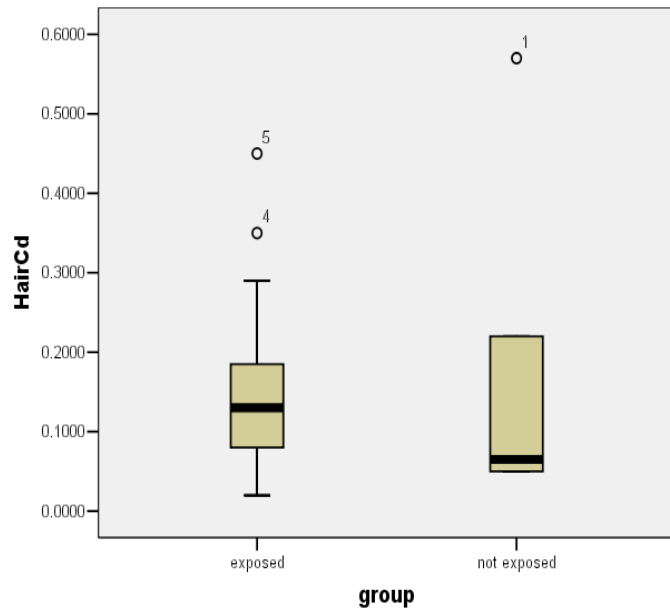


Figure 1 Hair cadmium concentrations for bore water users and non bore water users (mg/kg).

Figure 2: Hair cadmium and consumption of Home grown produce (mg/kg)

Summary

Concentrations of metals in bore water used for irrigation of home grown produce were lower than reported in previous investigations.

Urinary arsenic and lead concentrations considered very low and no difference was observed between bore water users and non bore water users.

Toenail metal concentrations were reflective of soil metal concentrations and were higher in the few samples provided by non bore water users.

There was a direct relationship between time spent gardening (hours) and the toenail metals concentrations observed.

Summary

These two small investigations show that:

- Metals concentrations in bore water used for is very variable but some high concentrations observed
- High % of residents growing and consuming home grown produce
- Human exposure study suggestive of increased exposure however metals levels in water lower than previously observed

Summary

Copper levels were high and likely to be related to copper water pipes, although copper also a metal associated with ASS.

The study was limited in the selection of biological measures of exposure noting that blood concentrations for some metals would be preferable measures of exposure in this study.

The study was small and a larger sample size is required to further elucidate the relationships observed.

Where to Next?

- More comprehensive study of human exposure to assess potential impact of metals in ASS affected areas.
- Need to understand the scale of the problem with respect to residential use of contaminated water eg. New data in areas such as Gwelup and areas North of Perth
- Need to assess health risks of exposure

