

# Impact of historical land use and gardening practices on metal concentrations and bioaccessibility in garden soils in Kelowna and West Kelowna, BC

Amanda Anderson & Matt Dodd\*

Royal Roads University, 2005 Sooke Rd, Victoria, BC, Canada, V8T 2L1



## Introduction and Objectives

Urban gardening is common in Kelowna and West Kelowna, two municipalities in the Okanagan, BC, Canada, a region known for its fruit orchards and wineries. The use of compost, fertilizers, herbicides and other soil amendments along with anthropogenic inputs such as automobile exhaust and tire wear, metal fabrication and recycling industries can potentially introduce metals into garden soils. Gardeners can be exposed to these contaminants through incidental ingestion, dermal contact or consumption of contaminated produce.

This study was therefore conducted to:

- Assess the distribution of metals in home and community garden soils in Kelowna and West Kelowna, BC.
- Determine the potential factors that contribute to elevated metal levels in garden soils.
- Evaluate the potential health risk associated with incidental ingestion of metals in contaminated garden soils incorporating bioaccessibility estimates.

## Methods

### Sampling

- 128 samples collected from 28 home and 17 community garden plots (Fig 1)
- Samples collected from the surface layer (0-25 cm)

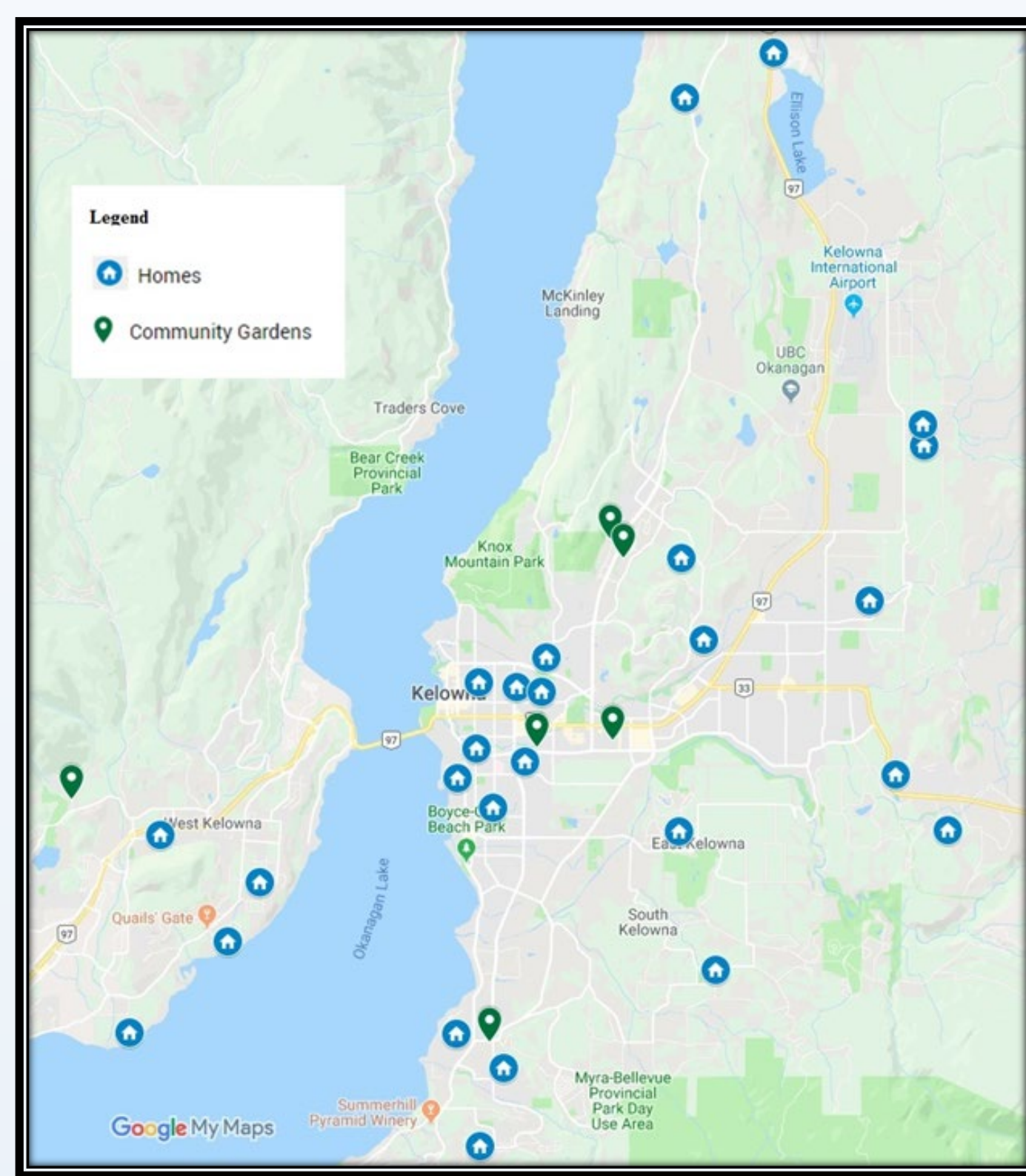


Fig 1: Sampling Locations

### Questionnaire completed during sampling

- Year of buildings
- Historical land use in the area
- Garden type (in ground or raised bed)
- Pesticide and herbicide use
- Use of soil amendments (compost, mulch, fertilizer, etc.).

### Analysis

- Soil samples air dried and sieved to <250 µm
- Soil pH determined
- Total metals determined with a Niton XL3t GOLDD XRF (USEPA Method 6200)
- 20 samples analyzed by ICP-MS for comparison; good correlation between the two methods for most metals
- In vitro bioaccessibility analysis conducted for 14 samples (USEPA Method 9200.2-86)
- Data compared to Canadian Council of Ministers of the Environment (CCME) soil quality guidelines
- Potential human health risk associated with soil ingestion determined using Health Canada (2004) protocols

## Results

### Total Metals

- Ba, Cd, Cr, Cu, Ni, Sb or Zn in some samples exceeded the CCME (1999) soil quality guideline for residential/parkland use (CCME R/P) (Table 1)

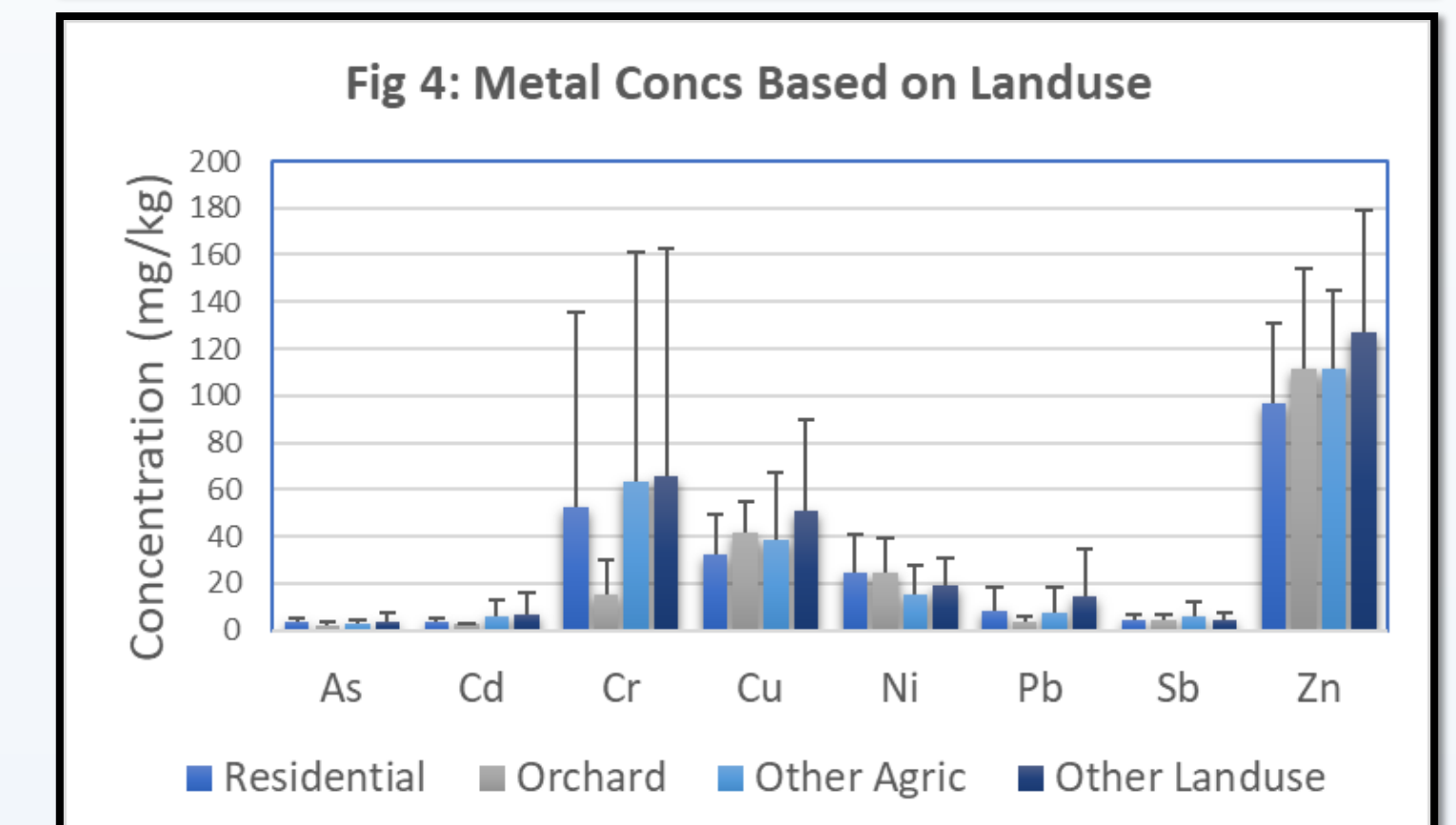
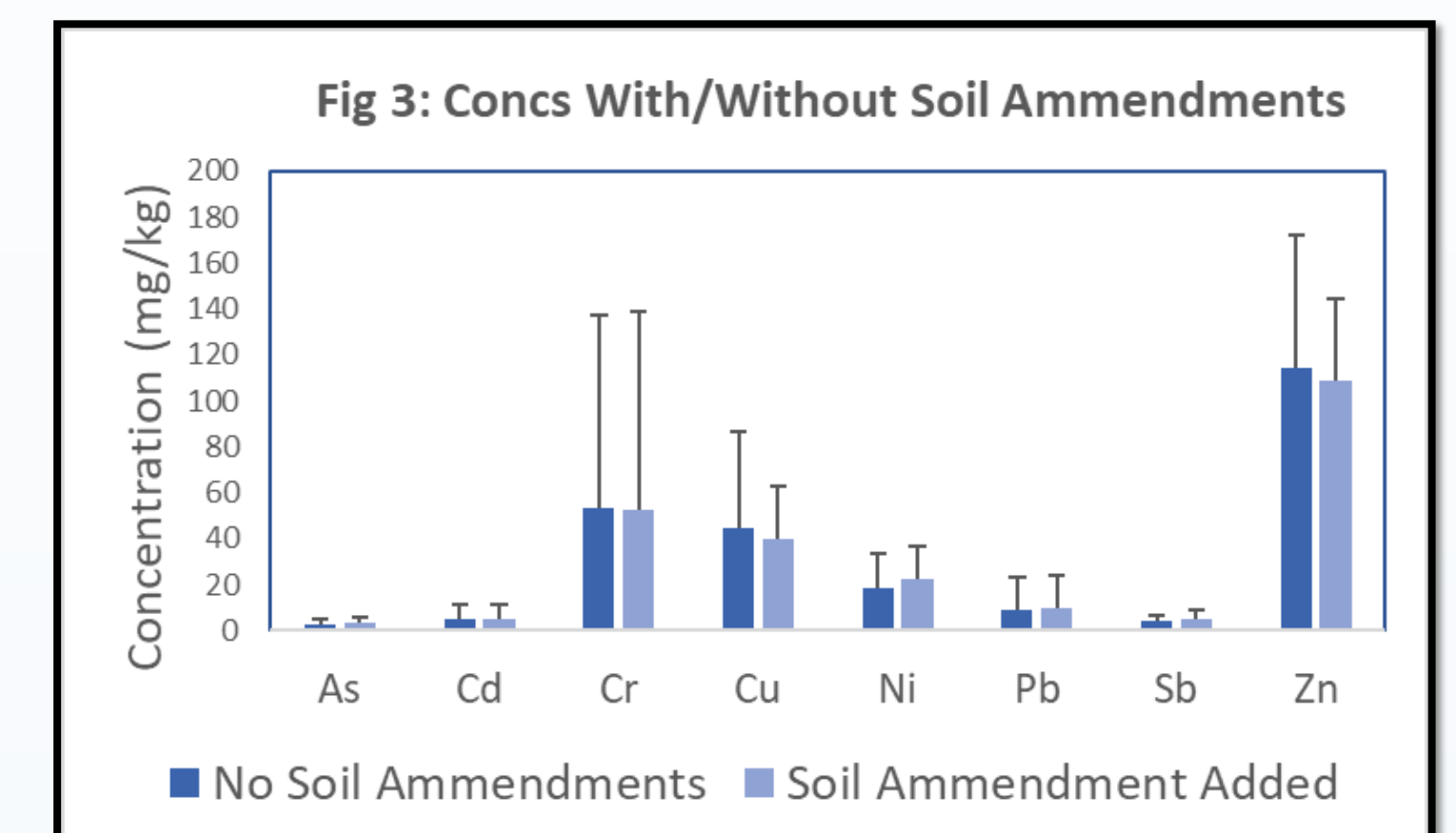
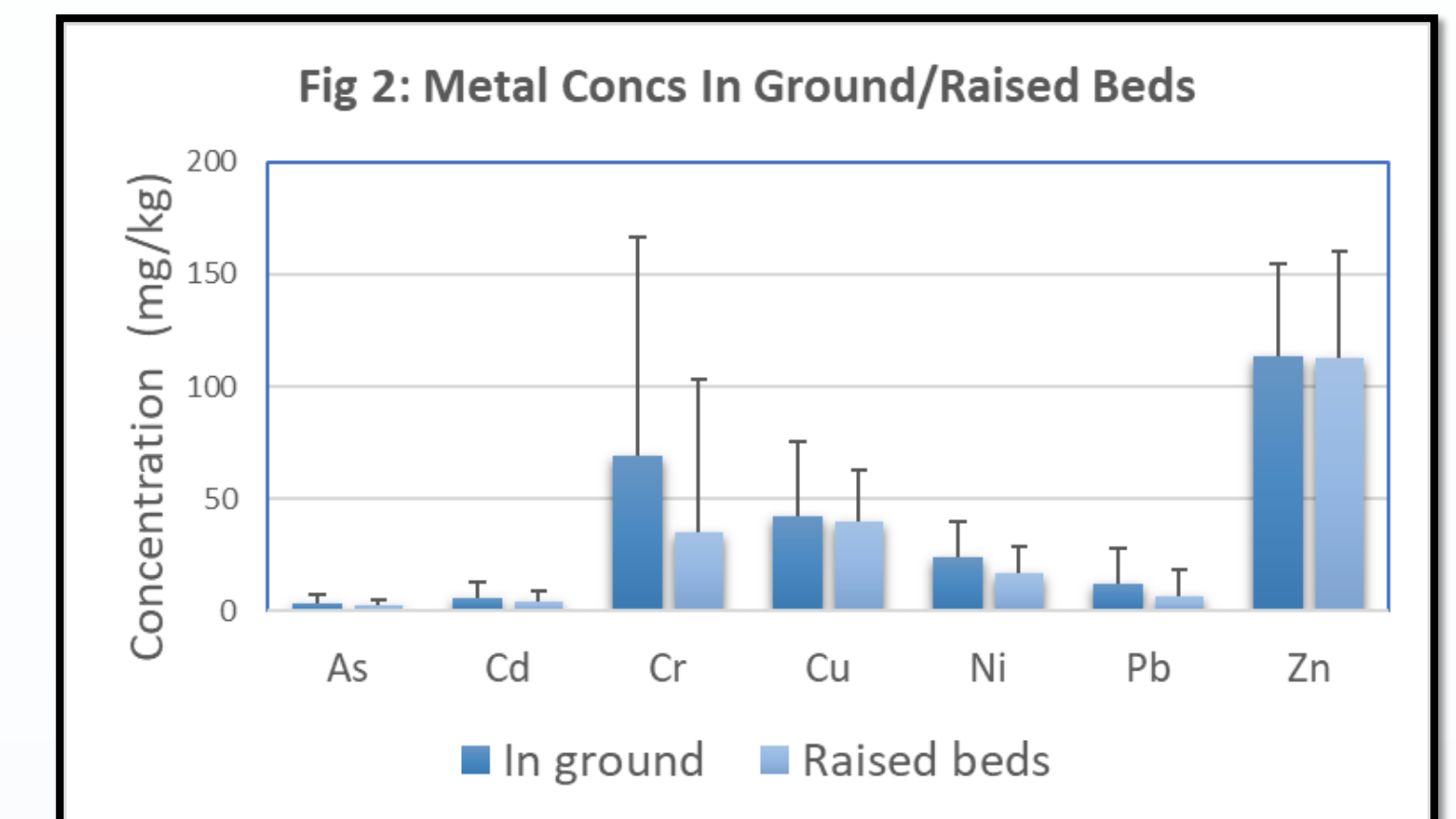
Table 1: Descriptive Statistics for Soil Samples (mg/kg)

	As	Ba	Cd	Cr	Cu	Ni	Pb	Sb	Zn
Mean	5.2	<b>619</b>	<b>18</b>	84	42	35	14	4.5	112
Std Dev	3.1	272	9.4	98	28	11	16	3.8	44
Median	4.3	<b>618</b>	<b>18</b>	28	35	34	8	3.3	104
Max	21	<b>1367</b>	<b>41</b>	<b>314</b>	<b>256</b>	<b>78</b>	85	<b>22</b>	<b>369</b>
95%tile	9.1	<b>1012</b>	<b>31</b>	<b>270</b>	<b>81</b>	<b>49</b>	54	13	198
CCME R/P	12	500	10	64	63	45	140	20	250

**Bold values** exceed the CCME guideline for residential/park landuse

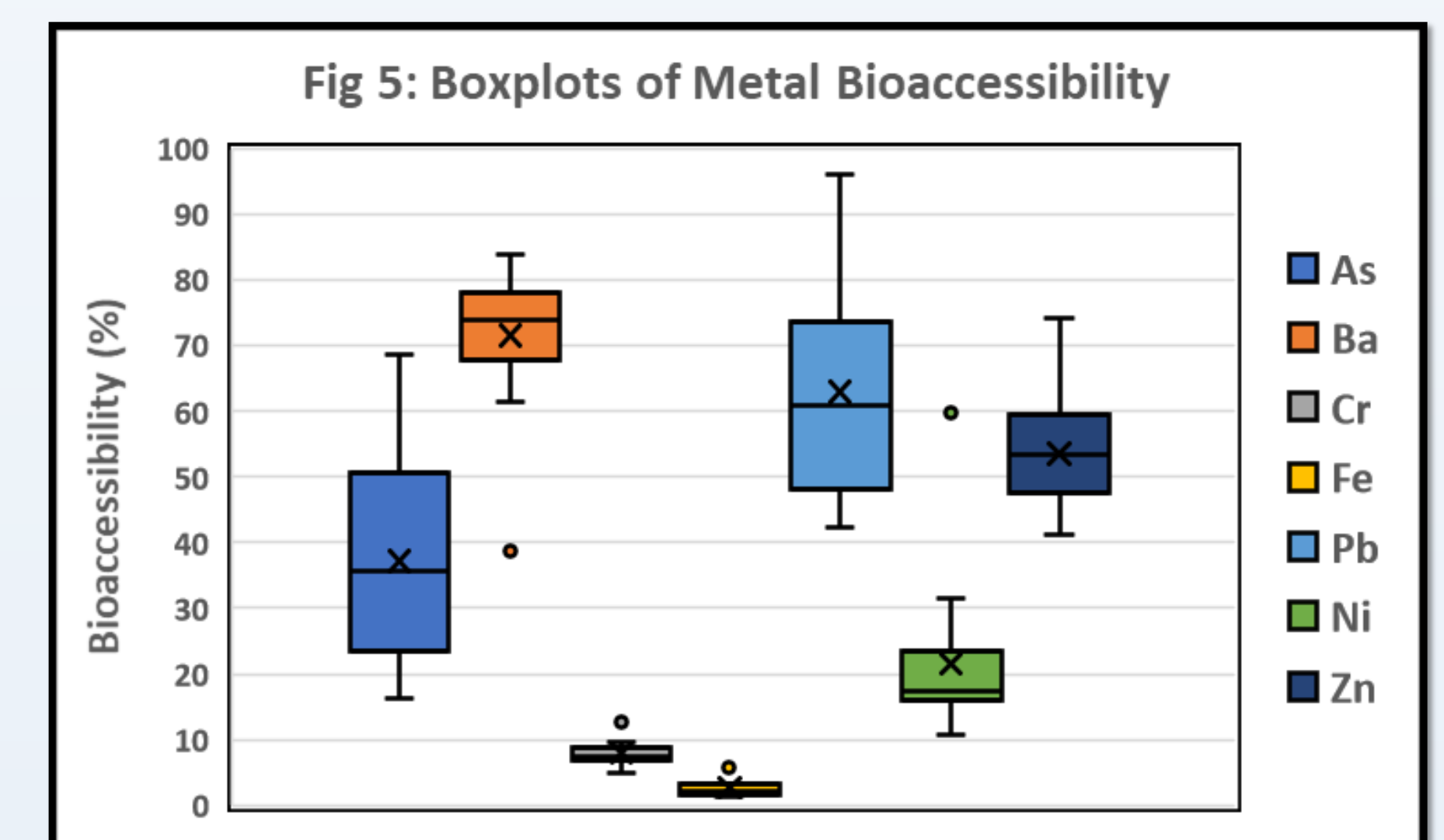
## Discussions

- Concentrations slightly higher in *in ground* gardens compared to *raised beds* for some metals (Fig 2).
- No statistically significant differences in concentrations between gardens with/without added soil conditioners or fertilizers (Fig 3)
- No statistically significant differences in lead concentrations between homes built before and after 1991
- Minor differences in concentrations based on landuse (Fig 4).
- Other historical landuse such as orchard, parking lot, wasteland, and flood plain appear to have the most impact on metal concentrations



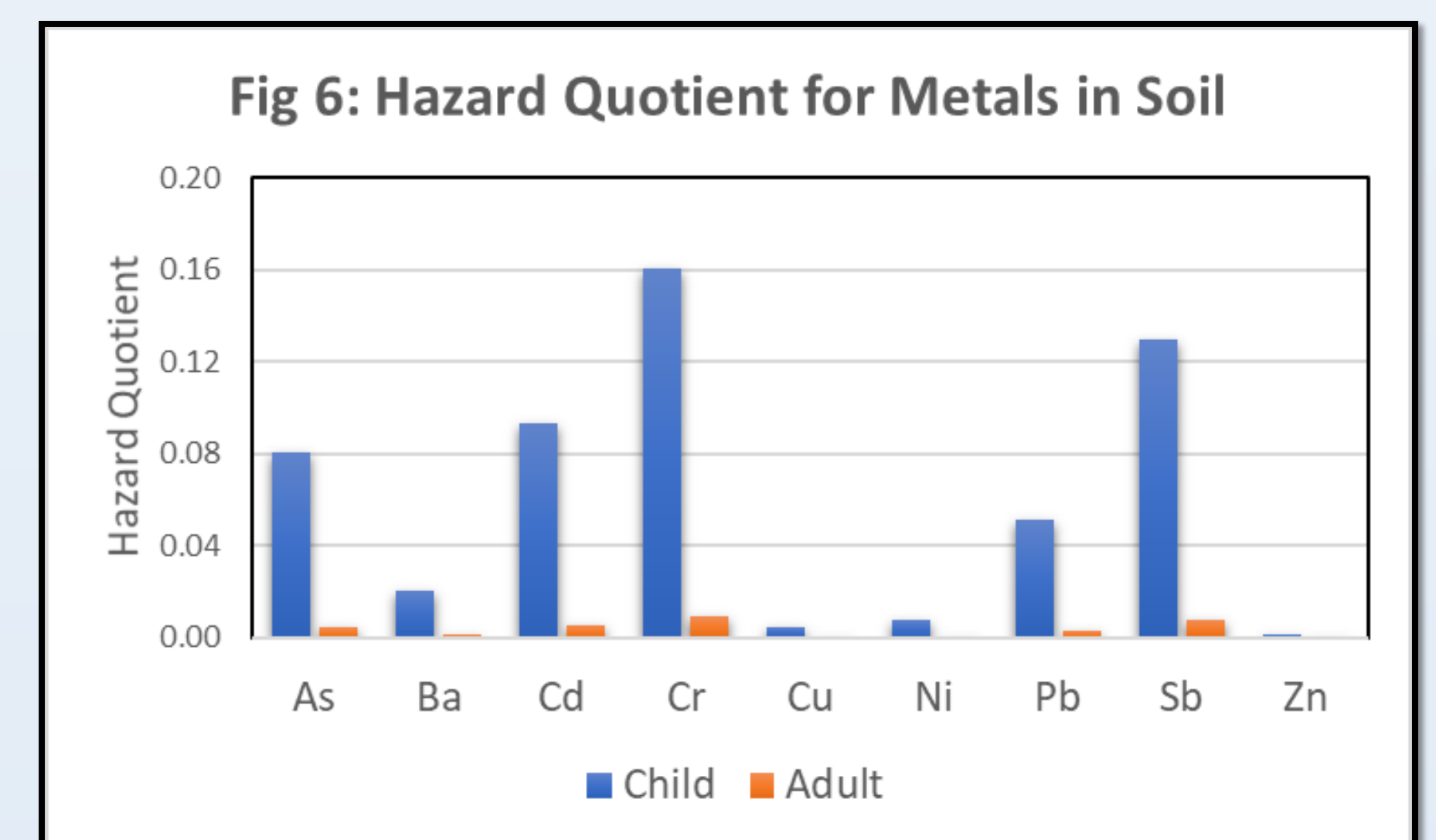
### Metal Bioaccessibility

- Variable bioaccessibility among the samples (Fig 5)
- May be due to metal speciation, soil pH, TOC, particle size, etc.



### Risk Characterization

- Based on the 95%tile metal concentrations and bioaccessibility, the overall risk associated with incidental ingestion of metals in the garden soils is low (HQ < 0.2) (Fig 6)



## Conclusions

- Metals including As, Ba, Cr, Cu, Ni, Pb, and Zn are present in garden soils in Kelowna and West Kelowna.
- Based on the hazard quotients obtained, the risk associated with incidental ingestion of metals in contaminated garden soils in Kelowna and West Kelowna is low.

## References

- CCME (1991). Canadian soil quality guidelines for the protection of environmental and human health
- USEPA (2012). Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead in Soil, EPA 9200.2-86
- Health Canada., (2004). Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment

## Acknowledgements

- CFI Canada & Royal Roads University