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Evaluating contamination exposure rates in different Urban Agriculture (UA) practices

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Introduction

Urban Agriculture (UA) is instrumental in instilling a degree of self-sufficiency in food production inevitable for a resilient and sustainable city. Nevertheless, urban soil can be a substantial source of contamination due to previous, ongoing or even adjacent land-use like heavy traffic, and consumption of fresh produce grown on such could be an added exposure pathway for urban population (Figure 1).

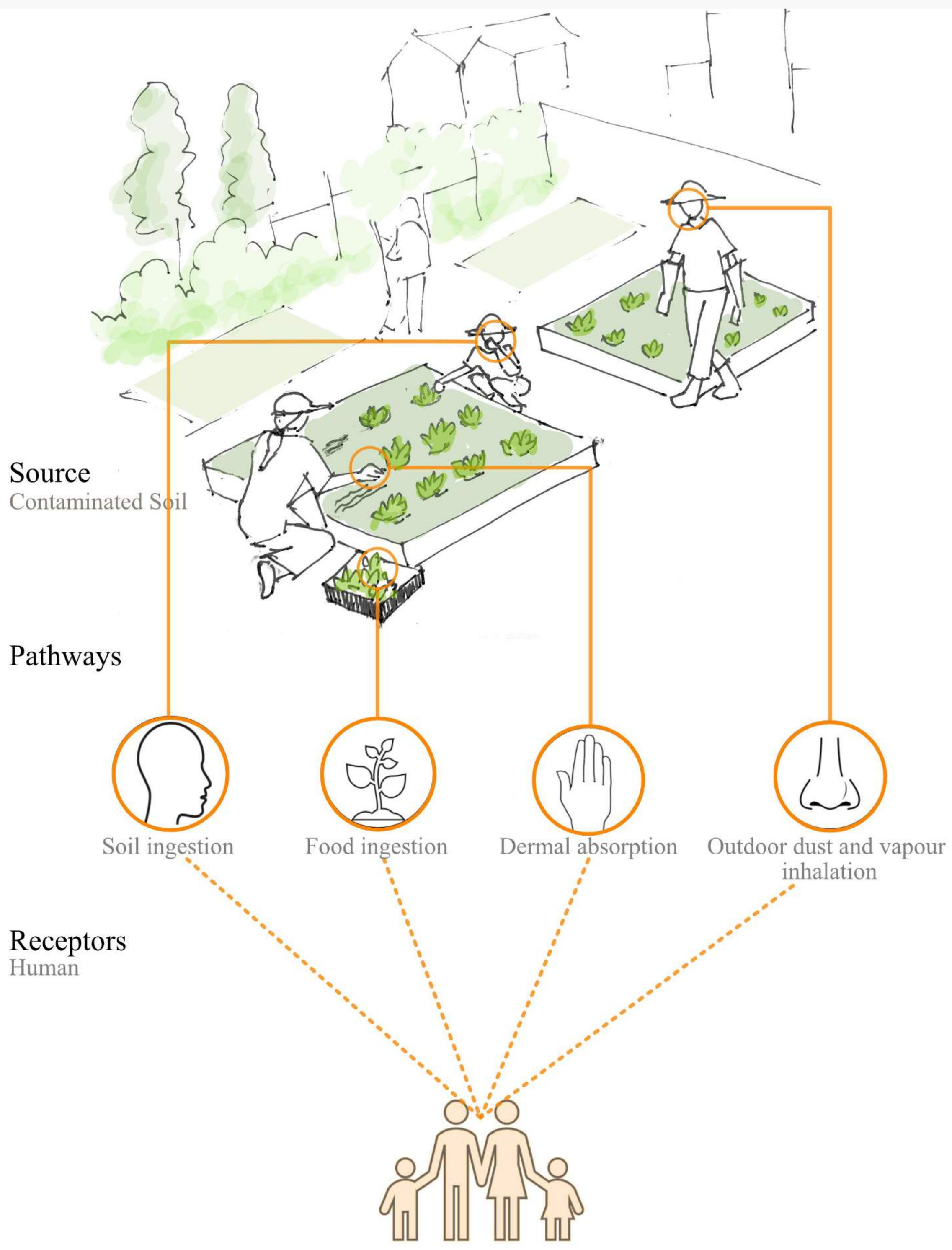

Figure 1: Conceptual model contamination exposure pathways related to UA practices.

These concerns lead many countries to follow strict regulation for gardening in urban areas considering the use as sensitive to contamination exposure as residential use. But there are many UA practices with varied degree of user involvement and management; the prevalent ones taking place well-out of residential periphery. However, there exist neither a definitive soil screening guideline that refers to such variations of UA practices nor studies on UA scenarios to modify the existing risk models.

Figure 2: Different UA practices.

Methods

This study identifies different UA scenarios (Figure 2) and compares the contamination exposure to highlight the difference of risk in them. An exposure risk model is created combining with UA scenario sensitive parameters to test on different practices. The scenario exposure data is to be collected from surveying different UA practice group in Gothenburg, Sweden.

Study Area

Gothenburg municipality (Göteborgs stad), where the Gothenburg city is located, is a municipality in the Västra Götaland county in Sweden. The municipality is home to around 600,000 inhabitants encompassing an area of about 450 sq. km (Figure 3).

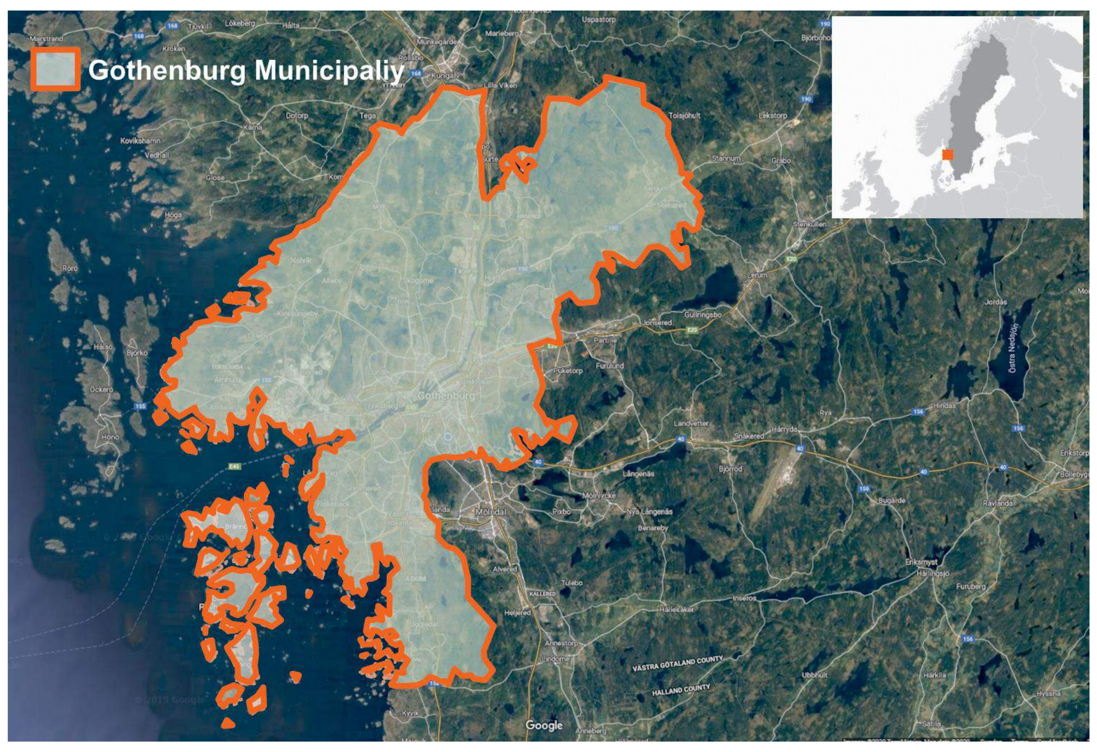

Figure 3: Map of the study area, Gothenburg municipality.

Risk Model

Site specific and population parameters

- Bodyweight, average lifespan, content of organic matter, soil particle content in air, etc.
- Data from existing studies, literature and soil sampling.

Substance specific parameters

- Toxicological reference values, bio-concentration factors, etc.
- 5 trace metals are selected for testing (Cadmium, Copper, Lead, Mercury, and Zinc).
- Data from previous studies and literature.

Scenario specific parameters

- Exposure time, duration, frequency, type of food grown on site, etc.
- 6 different UA scenarios (Figure 2) will be tested.
- Data from in-depth interviews and questionnaire surveys (currently scheduled to take place in July, 2020).

Analysis

- The risk model is set up in Excel using @Risk as an add-in to model uncertainties by Monte Carlo simulations.
- The risk model is based on the models and data used by the SEPA (Swedish Environment Protection Agency) guideline value model.
- The model is run for 4 exposure pathways, 6 contaminants, 6 UA scenarios, and 2 types of users (adult female and child).
- A sensitivity analysis will be carried out to study the impact of the input parameters on the output results.

Preliminary Results

The preliminary result with elicited data shows that practices with residential or extensive use such as house garden, neighbourhood greenspace and arable land predictably have high risk (Figures 4 and 5). More common UA uses such as allotment gardens are much less risky when exposed to the same concentration of contamination while dropping to almost none for meadow orchards.

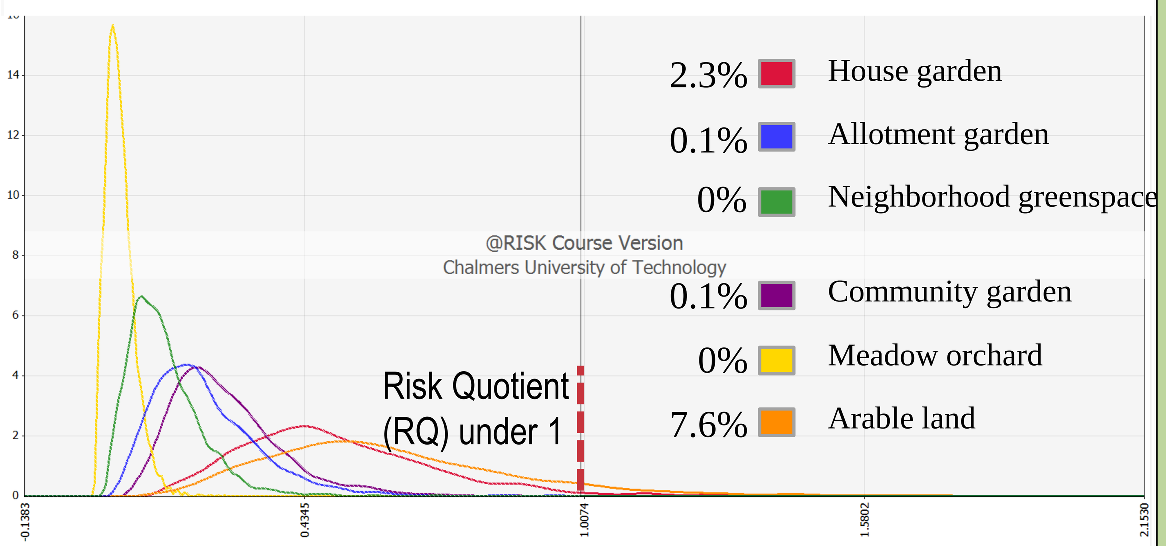

Figure 4: Comparison of acceptable risk for lead (Pb) in UA scenarios for child users (preliminary result with elicited data).

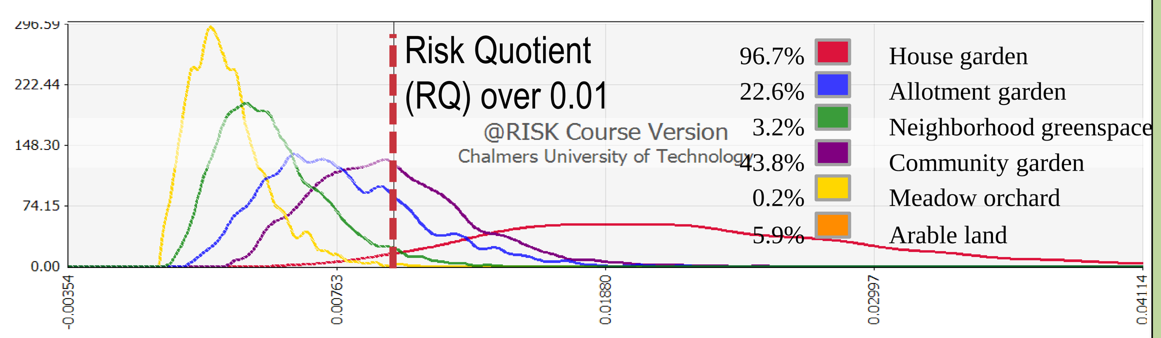

Figure 5: Comparison of acceptable risk for lead (Pb) in UA scenarios for adult (female) users (preliminary result with elicited data).

The preliminary study used a risk model where a Risk Quotient (RQ) was used to determine the relative risks of different UA practices. RQ values over 1 indicates the existence of exposure risk in that scenario for that substance. Values under RQ 1 indicates an acceptable risk. The study was done using existing data and the Monte Carlo simulations were run for 5000 iterations. Data collected via the questionnaire survey will be used for more accurate input data which better represents real life scenarios.

Conclusion

Retrofitting abandoned, and derelict lands gives UA an opportunity to find a place in the competitive urban land market. More knowledge on the exposure from soil contamination from different UA practices would provide more options to bring back obsolete land in use.

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