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REPRESENTATIVE CONCENTRATIONS
IN A QUANTITATIVE RISK ASSESSMENT

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Representative Concentrations

- Representative concentrations of pollutants are one of the basic input parameters for quantitative assessment of health risks from contamination of soil, groundwater and soil air

- Determination of these representative concentrations (RC) is one of the most important outputs of the assessment of the results of the soil pollution investigation.

Upper confidence Limit

- Most guidelines recommend using the 95% Upper Confidence Limit (UCL95) of the mean of the selected data set as the representative concentration.

- However, the use of UCL requires meeting strict criteria for statistical representativeness of the input data set for its calculation.

Upper confidence Limit

- In the first place, the sampling points must be distributed in a statistically random manner throughout the area to be investigated, and there must be a minimum number of samples in relation to the extent of the area.

- In case of more complicated sites, it is recommended to divide the entire site into several sub-units that are statistically quasi-homogeneous. Each of these sub-units is then sampled and evaluated separately (including RC determination).
  This approach requires that there is some prior knowledge on the distribution of contamination throughout the site.

Real World

- In most cases we do not have a statistically homogeneous data set from a given site.

- Typically, data on a site contamination are obtained by biased sampling, which is primarily focused on identifying hot-spots and delineating an extent of pollution clouds.

- The situation is further complicated if there are more hot spots on the site.

- The use of statistical methods to evaluate data sets obtained in this way is not correct.

- Subdividing a site into several quasi-homogeneous units is often problematic for several possible reasons.

Alternative approach for quantification of an on-site health risk

- In many cases, it is possible to avoid the indicated complications in the specification of representative concentrations by completely abandoning their determination and proceeding in one of two ways, which allow to directly define subareas with a different risk levels within the whole site.

Alternative approaches

- (a) Contour lines of contaminant concentrations based on data from sampling are constructed using geostatistical methods (kriging). The isoline of the calculated limit concentration, corresponding to the selected threshold level of acceptable risk, is then inserted into the resulting image.

- (b) The risk corresponding to the concentration of the contaminant at the given sampling point is calculated individually for each sampling point. Using geostatistical methods, the calculated values are then used to directly plot the EILCR or HQ isolines (for carcinogenic or non-carcinogenic risks).

Alternative approaches

- If a broader range of contaminants is involved in the site pollution, it is recommended to simplify the risk assessment by first identifying the so-called priority contaminants that contribute decisively to the potential health risks (e.g. more than 95% - see US EPA 1989).
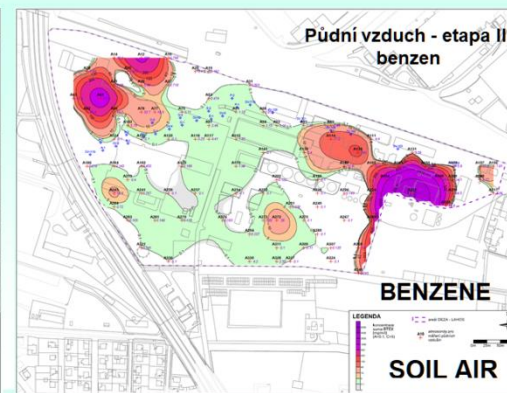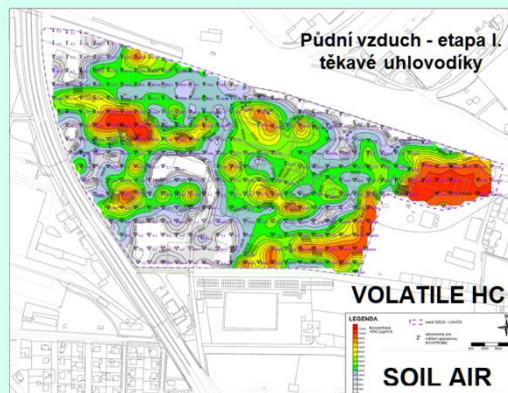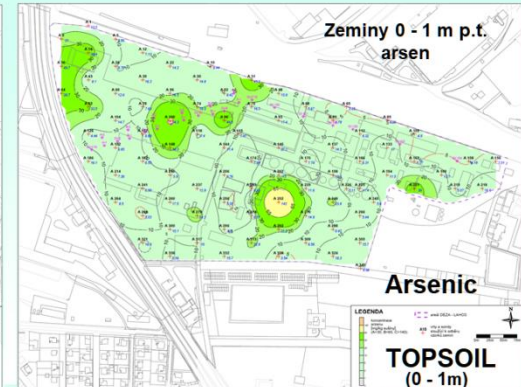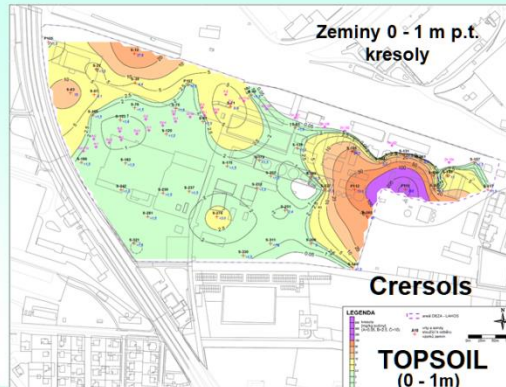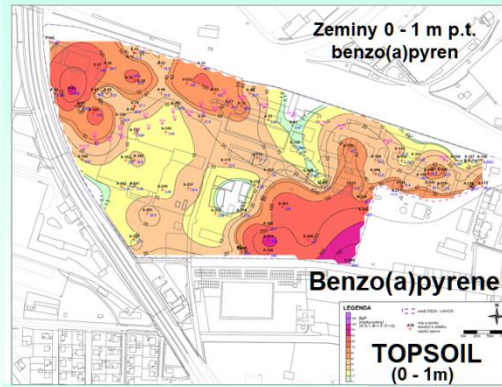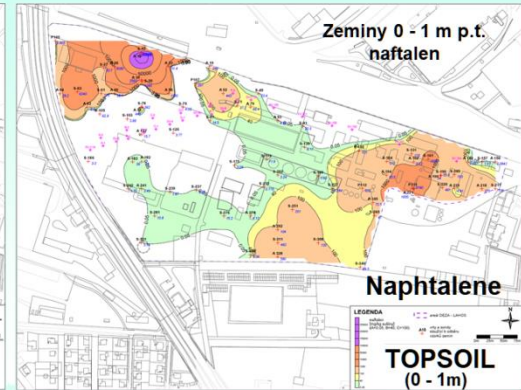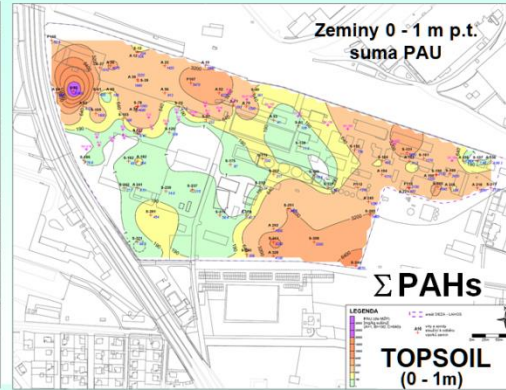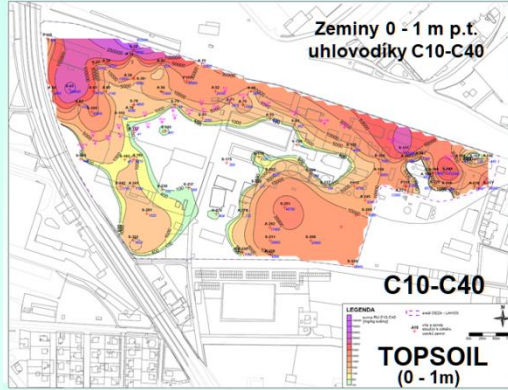
Example 1 - introduction

- Brownfield area of the former chemical plant

- Extensive and deep soil and groundwater pollution by wider range of contaminants

- Very attractive location in terms of commercial usage

- Site remediation unfeasible because of huge financial requirements
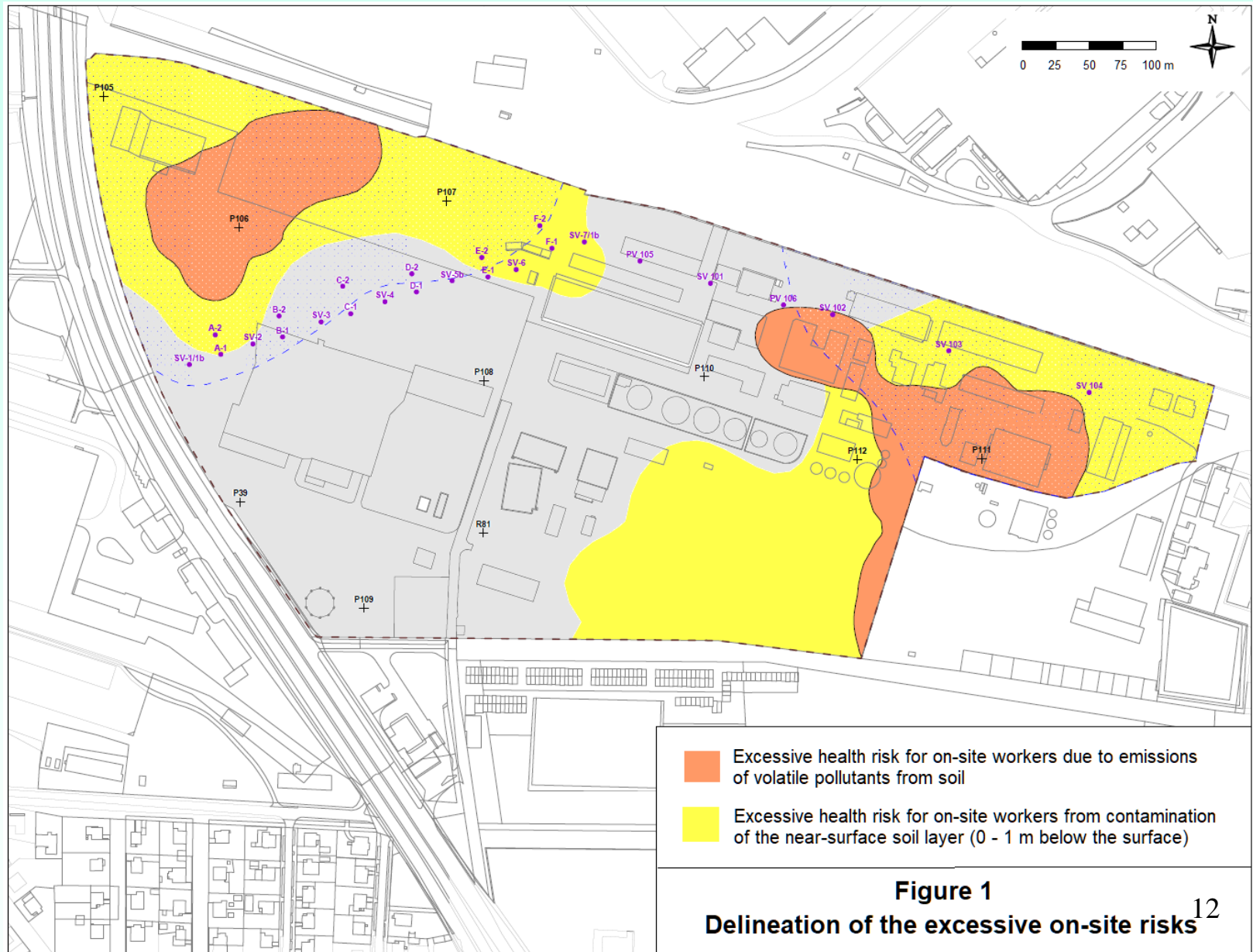
Example 1 – on-site risks

Two sources of the health risk for potential future site users:

- contaminated topsoil layer (0 – 1 m below the surface)

- emissions of volatiles from deeper soil and groundwater

Example 1 – topsoil and soil air pollution

Example 1 – on-site risk synthesis

Excessive health risk for on-site workers due to emissions of volatile pollutants from soil

Excessive health risk for on-site workers from contamination of the near-surface soil layer (0 - 1 m below the surface)

Figure 1
Delineation of the excessive on-site risks

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Example 2 - introduction

- a large unused area where an industrial enterprise used to be located

- heavy, extensive and deep pollution by chlorinated solvents

- the site is located in the middle of a luxury residential area of a large city

- very attractive for developers

- Site remediation unfeasible because of huge financial requirements

Example 2 – on-site risks

- Emissions of volatiles from deeper soil and groundwater.

- Cumulative on-site risks to potential future residents from emissions of the two priority pollutants (PCE and TCE) were calculated for each documentation point.
Risk contours were constructed using geo-statistical methods. The results are illustrated in the following figure.

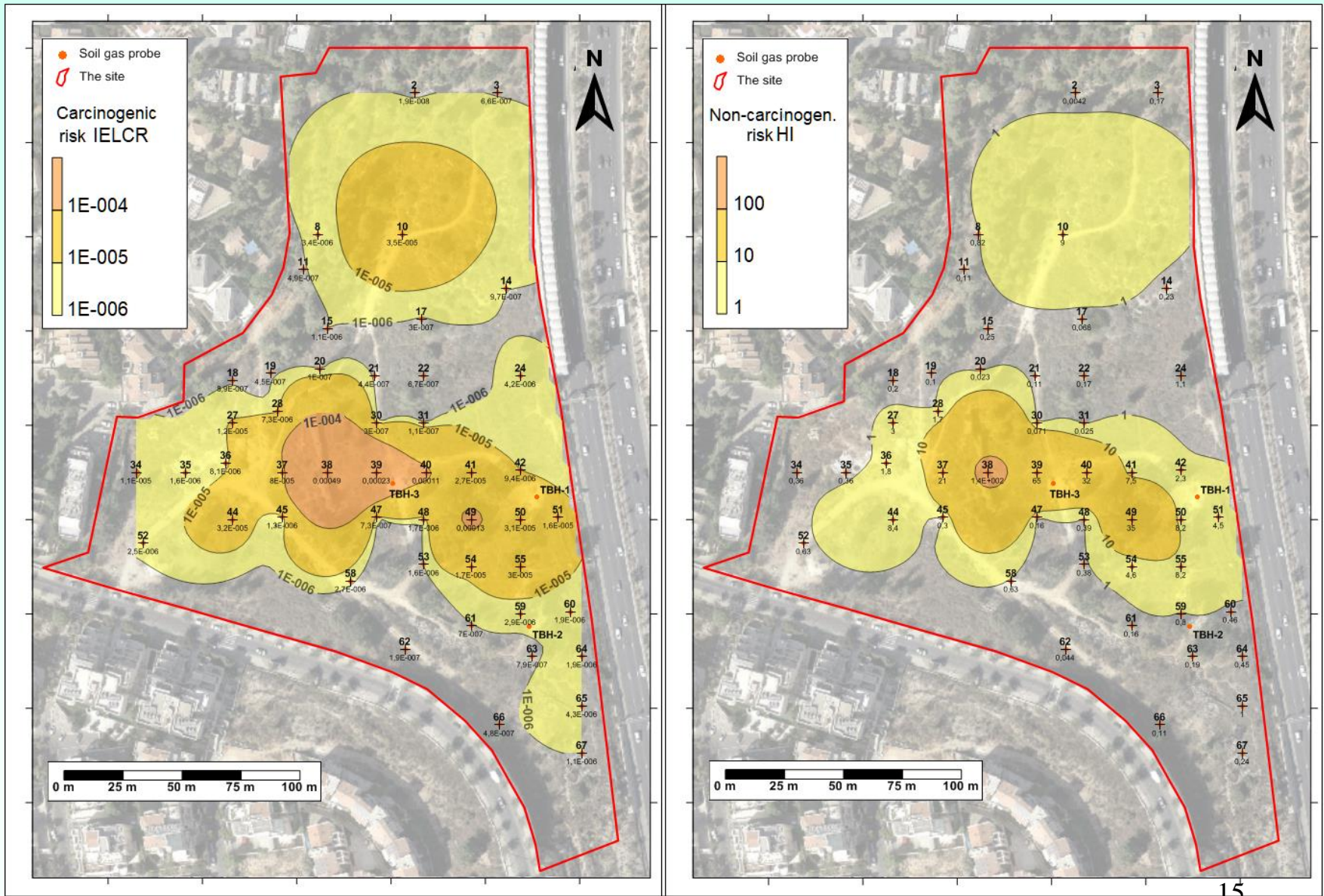# Example 2 – on-site risk – residential scenario

Figure 2: Cumulative on-site risks for residents from emissions of PCE and TCE from soil

Summary

Presented examples illustrate possibilities of avoiding difficulties with determination of representative concentrations for quantitative assessment of on-site health risks from soil contamination, especially for more complex and larger sites and for datasets from non-random (biased) sampling.

Conclusions

The outlined approaches to assessing on-site risks from soil contamination offer these possibilities:

- simplification of the risk quantification process;

- more precise and illustrative determination of the health risk distribution throughout the site area;

- more flexibility in delineating sub-parts of the site suitable for different types of functional use;

- more flexibility in designing remedial measures for risk reduction in the sub-areas of the site.

Thank you for your attention

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