Operational Programme "Increase of economic Competitiveness" "Investment for your future"

RECOLAND - Multicriteria decision support system for the remediation of historical contaminated industrial areas with persistent and toxic pollutants

The total project value is **5.936.398,16 lei, (≈ 1.450.000 €), from which non-reimbursable fiunancial assistance is 5.725.580,00 lei (≈ 1.400.000 €). The project non-reimbursable eligible value from European regional development fund (ERDF) is 4.752.231,4 lei (≈** 1.160.000 €), the non-reimbursable eligible value from national funds is **973.348,6 lei (≈** 240.000 €), and the non-eligible value is **210.818,16 lei (≈** 50.000 €).
Project co-funded by **the European Regional Development Fund.**

Human Health Risk Assessment of Organochlorine Pesticides in agricultural soils

Diana M. Cocârţă[1], Cristina Dumitrescu[1], Silvia Neamţu[2], Reşetar-Deac Ana Maria[1], Adrian Badea[1]

[1]University "POLITEHNICA" of Bucharest, Faculty of Power Engineering, 313 Splaiul Independentei, Sector 6, 060042, Bucharest , Romania.
[2]Ministry of Environment and Forests, Libertăţii Blv. 12, Sector 5, 040129, Bucharest, Romania.

Generalities:

Even that synthetic organochlorine compounds have been used in Romania in the past as herbicides, insecticides, fungicides and termiticides, these substances persisted over the years in soil and other environmental matrices. Concern on organochlorine pesticides (OCPs) increased because of the environmental persistence, bioaccumulation, toxicity and potential for long-range environmental transport.

Research aim and used approach:

As scarce research exists concerning the human health based on OCPs in contaminated agricultural areas, the main aim of the present work was to investigate the contents and distribution of organochlorine pesticides (α-, β-, γ-, δ- HCH, p, p' – DDE, p, p' – DDD, and o, p' - DDT) in soil profiles (soil depths 0 – 0.2 m and 0.2 – 0.4 m, respectively) and to assess human health risk from the contaminated soil used in agriculture. Once that the interested contaminated area was identified, the general framework for the management of contaminated sites starting from the risk assessment was used (as shown in Fig. 1). In order to evaluate the human health risk from OCPs in contaminated soil, the US EPA 98 approach was used [1] for the exposure assessment and to predict risks for residents exposed to soil contaminated with OCPs. Health risk quantification and customizing the interested area were done using data from the available models developed by USA [1], Netherlands [2] and Canada [3], while others necessary parameters were identified by the research team based on the specific local conditions.

Results:

In order to obtain a correct and comprehensive exposure assessment, soil samples were collected from one of the most contaminated areas from Central Romania in order to identify OCPs concentration levels in soil. Even though the studied area is known as mainly polluted with heavy metals, also organochlorine pesticides were found. From all analyzed OCPs, just in case of HCH compounds concentration level in soil was identified higher than the reference values used in Romania. Taking into account that Lindane (or hexachlorocyclohexane, γ - HCH) has the main importance between total HCH in terms of identified concentration level (as shown in fig. 2), a special attention was paid to it. For this antiquated and toxic pesticide once used extensively worldwide, and also in Romania until 1985 when it was interdicted by the national regulation [4], the intervention threshold for sensitive use according to the Romanian Order 756/1997 [5] has been exceeded almost four orders of magnitude: the γ- HCH concentration level was 0,180 mg/kg$_{dw}$ respect to 0,05 mg/kg$_{dw}$ considered as acceptable for agricultural land. In this framework, and considering also the local context, the human health risk was assessed in correlation with OCPs identified concentration levels. Fig. 3 illustrates the distribution ofγ-HCH concentration level in the studied area for the sampling layer of 0 – 0,2 m, while fig. 4 considers the concentration distribution for the sampling layer of 0,2 – 0,4 m. Both figures illustrate concentrations of γ-HCH that are exceeding the threshold for sensitive use.

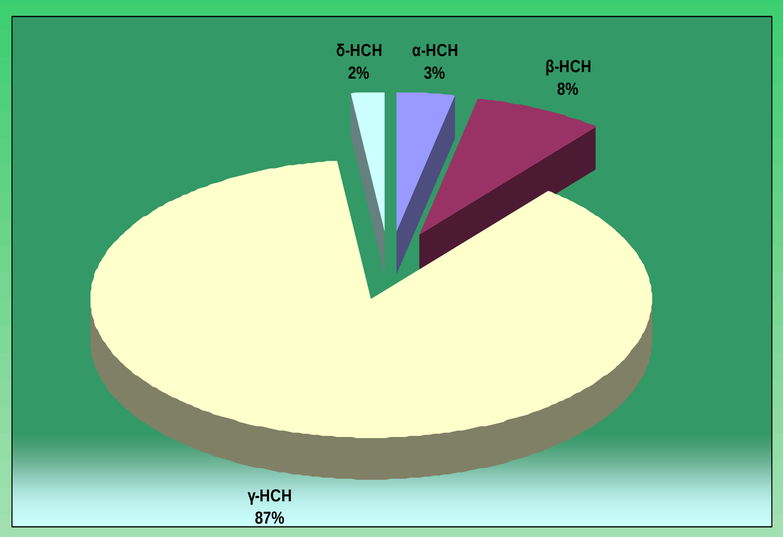

Figure 2. Distribution of α-, β-, γ-, δ- HCH concentration level respect to ΣHCH concentration level

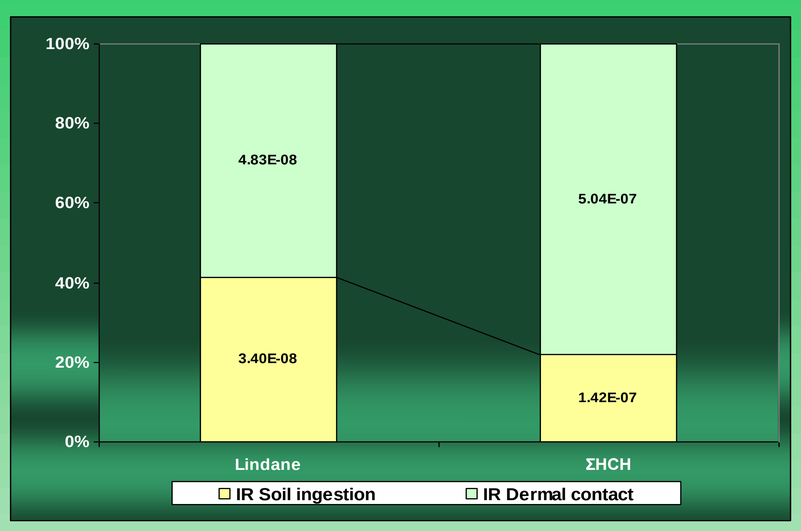

Figure 4. Individual Risk for the exposed population considering the agricultural land use and different exposure pathways

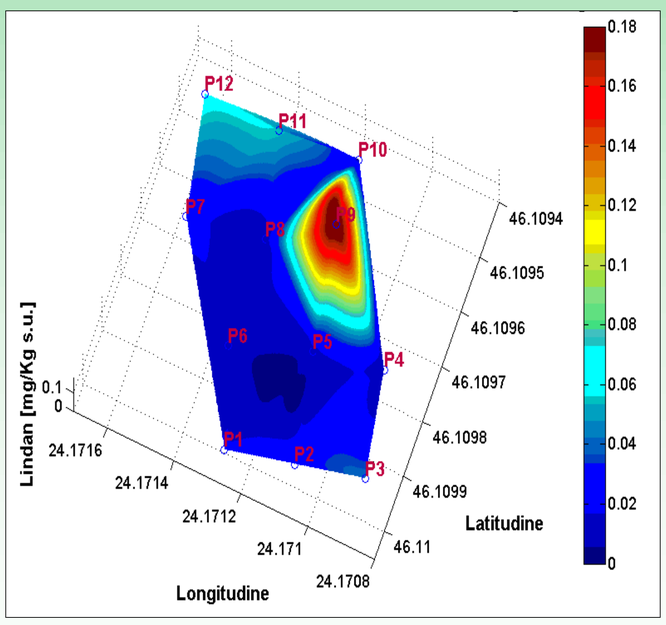

Figure 2. Concentration of γ-HCH in the studied area (sampling layer of 0 – 0,2 m)

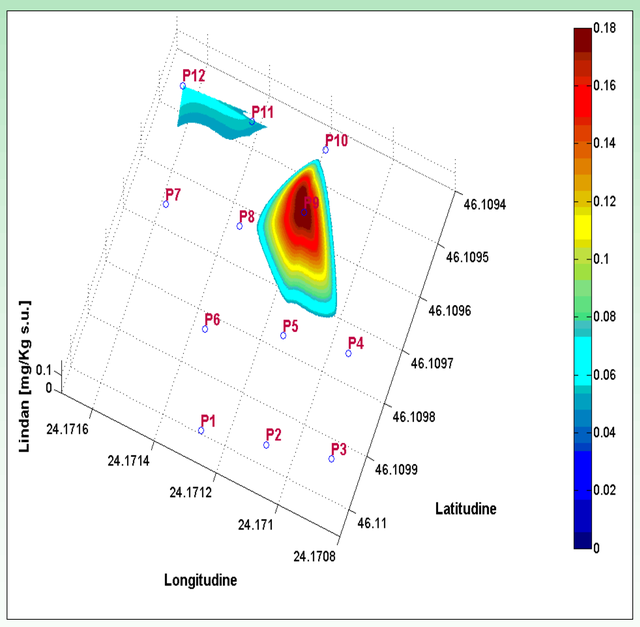

Figure 3. Concentration of γ-HCH in the studied area (sampling layer of 0,2 – 0,4 m)

Figure 1. General framework for the management of contaminated sites starting from the risk assessment (after Swartjes F. A., 2011)

The risk assessment tool developed within the framework of the RECOLAND project has been used for risk evaluation considering soil ingestion and dermal contact exposure pathways and other particularities according to the local context (for instance agricultural scenario). The generally acceptable lifetime health risk (10^{-6}) was considered as starting point for all the considerations during the research. The risk was quantified only for the compound for which the concentration in soil exceeded the threshold level (Lindane). Additionally, even that the concentration level of ΣHCH was below the limit (0,436 mg/kg$_{dw}$ respect to 0,5 mg/kg$_{dw}$ from the national regulation), also the individual risk as a consequence of exposure to ΣHCH was assessed. Results showed that health risks mainly came from two exposure pathways: dermal uptake and soil ingestion. Figure 4 shows results of health risk assessment for the contaminated soil with γ-HCH and ΣHCH, respectively. As it can be noticed, the main exposure pathways for both compounds categories (sum or individual HCH) is the dermal contact. If in case of γ-HCH the dermal contact exposure pathway has a contribution of about 60%, while in case of ΣHCH the percentage is increasing to 80%. These kinds of considerations are very important for environmental managers in case that the estimated health risk is higher than the acceptable lifetime health risk. In our study case the individual risk (IR) was 6,46 x 10^{-7}. This value is below the EPA's acceptable risk range.

Conclusions

1. From all analyzed organochlorine pesticides, just in case of γ-HCH the identified concentration level was over the intervention threshold for sensitive use according to the Romanian Order 756/1997.
2. Even that in case of γ-HCH the intervention threshold for sensitive use was over the limit, it was not the same in case of ΣHCH.
3. Results concerning the distribution of γ-HCH concentration in soil layers showed that Lindane concentration is decreasing in the same time with increasing depth layers.
4. Health risks assed in our study case evidenced that the mainly exposure pathways are dermal uptake and soil ingestion and IR is lower than EPA's acceptable risk range.
5. The same kind of approach as illustrated across the present work could allow environmental managers to reduce health risks to local residents.

References

[1] US Environmental Protection Agency, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Report EPA/540/1-89/002, 1989.
[2] Brand e, Otte PF, Lijen JPA, 2007, CSOIL 2000: an exposure model for human risk assessment of soil contamination, A model description, RIVM report 711701054/2007, Ministry of Housing, Risks in relation to Soil Quality, 2007.
[3] Health Canada, Environmental health Assessment Services Division Safe Environments Programme, Federal Contaminated Site Risk Assessment in Canada, Guidance on human health preliminary Quantitives risk assessment (PQRA), September 2007.
[4] Romanian Ministry of Agricultural and Food, directive No 20/1985 (in Romania).
[5] Romanian Ministry of Water Management, Forestry and Environmental Protection, Order for Approving the Regulation for Assessing the environmental Pollution, No 756/1997.

This research was developed based on the results obtained within the RECOLAND research project supported by the Operational Programme "Increase of the Economic Competitiveness" POSCCE-A2-O2.1.2.-2009-2, RECOLAND ID519, SMIS-CSNR:11982, Nb. 182/18.06.2010 (2010-2013).