"Transport and destination of a soil contamination caused by the Maceda’s old dump"

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Introduction

The Maceda’s dump was closed after 20 years of exploration, in 1998, due to concern about the contamination of the semi-captive aquifer that supplied, at the time, the city of Ovar and beaches Furadouro, Cortegaça and Esmorriz. It is assumed that the dump has about 38 thousand m³ and a height of 12 m, which is divided into 4 levels of 3 meters. There is no record of the waste deposited in this trash, so it is assumed that there are several contaminants in the leachate, so an organic and inorganic contaminant, tricloethylene (TCE) and lead, respectively, was studied.

TCE is naturally produced by certain species of seaweed, is a colorless liquid, highly soluble in water, it is used as a chemical for the production of other chemicals used in industry and commerce as degreasing agent and solvent ink and adhesives (PubMed, 2020). Lead is a metal, usually found combined with other elements in the environment, is variously used because of its ductility and corrosion resistance is rated by the EPA as probable human carcinogens (ATSDR, 2020).

Aim
➢ Determine the distribution of the contaminant for each of the environmental compartments / sub compartments under study (e.g. in the soil, it must consider its three phases - solid, liquid and gaseous);
➢ Calculate the space-time evolution of concentrations in groundwater, assuming a constant discharge from the dumpster (in step disturbance). Consider a spatial distribution one- and two-dimensional.
➢ Perform a quantitative risk analysis admitting that 500 m from the dump there is a well to collect water for consumption by a family with children.

Methodology

Thus, in order to analyze the distribution of the contaminant in the soil in the landfill area, a Mackay level 2A model (system in equilibrium with sources and sinks, in steady state) was used and applying fugacity analysis. Obtaining the fugacity, from equation 1, is possible to calculate the concentration of the contaminants, as this is equal to the fugacity product due to its compartmental capacity.

\[ f = \frac{\sum_{i=1}^{n} \Delta T \cdot C^2_i \cdot \sigma_i}{\sum_{i=1}^{n} (\Delta V \cdot \lambda_i - \sigma_i)} \]

Bearing in mind that the contamination of the dump is continuous, an indicial disturbance was assumed to analyze the advective-dispersive transport in a uni (eq. 2) and bidirectional (eq. 3) solution for space-time analysis.

\[
C(x,t) = \begin{cases} 
C_0 \frac{x}{2} - \frac{x-ut}{\sqrt{4Dt}} e^{-\frac{x^2}{4Dt}} & x \geq ut \\
C_0 \frac{x}{2} + \frac{x+ut}{\sqrt{4Dt}} e^{-\frac{x^2}{4Dt}} & x < ut
\end{cases} \]  

\[
C(x,t) = \begin{cases} 
C_0 \frac{y}{2} - \frac{y-ut}{\sqrt{4Dt}} e^{-\frac{y^2}{4Dt}} & y \geq ut \\
C_0 \frac{y}{2} + \frac{y+ut}{\sqrt{4Dt}} e^{-\frac{y^2}{4Dt}} & y < ut
\end{cases} \]

\[C_0:\ \text{initial concentration}
\]
\[u:\ \text{convective transport speed}
\]
\[t:\ \text{time}
\]
\[D:\ \text{dispersion-diffusion coeffi ciente}
\]
\[\sigma:\ \text{dispersion-diffusion coeffi ciente in the x direction}
\]
\[\lambda:\ \text{dispersion-diffusion coeffi ciente in the y direction}
\]

It was also possible to carry out a quantitative risk analysis, assuming that there is a family with two children, one aged between 6 and 12 years old and another aged between 2 and 6 years old, who lives between the dump and the coastline, 500 m from the dump, where their exposure is since they drink water from a well.

To conduct the study of the models appealed to the Matlab.

Results

Regarding the TCE, it will be spread over the 3 phases of the soil, with the amount in air, water and particles equal to 1.43 x 10⁻⁵, 6.93% and 93.07%, respectively. Lead will be distributed among the three compartments as follows: 0.01% in air, 0.02% in water and 99.97% in particles.

Analyzing 22 years of contamination and taking as initial TCE concentration 0.05 mg/L.

Assuming the same conditions for lead as the TCE and a lead concentration of 0.5 mg / L, we will obtain similar graphs. Making quantitative risk analysis, the carcinogenic risk and toxicity index in both contaminants are low, with the lead presents a value smaller than the TCE. This risk increases with age, due to the fact that the exposure is continuous.

Conclusion

It is concluded that the parameter that most influences dispersion and risk is the contaminant and the time of analysis. Since different contaminants reflect different plumes of contamination and risk associated with concentrations.

In the area surrounding the dump there are no houses, but in the present study one of the objectives to be accomplished was to assume the existence of a well for the collection of a family that resided 500 meters from the dump. The dump doesn’t present much risk associated with leachate, but the lack of nearby dwellings links greater security for the population.

References