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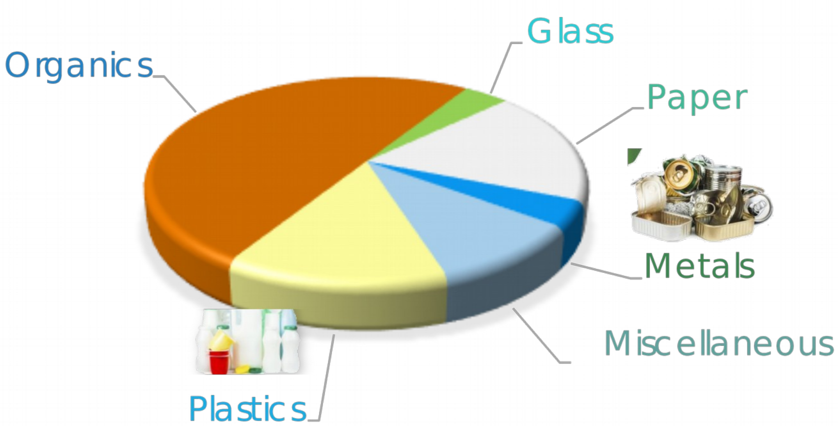
Total organic carbon as a proxy for metal release from biostabilized MBT wastes

Alessio Lieto*, Irene Chiapperini, Iason Verginelli, Daniela Zingaretti, Francesco Lombardi

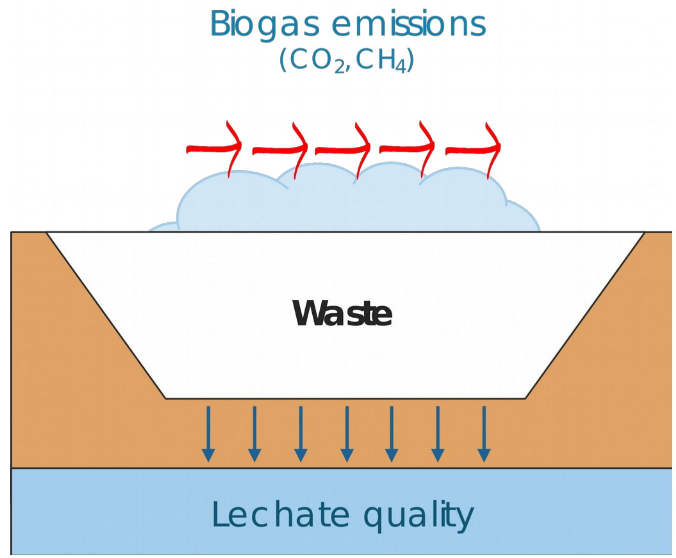
TOR VERGATA
UNIVERSITY OF ROME
Department of Civil Engineering

Municipal Solid Wastes (MSW):

- Large quantities of organic materials, depending on the country economy and the waste management policies (25 - 70% of the produced MSW)
- Potential impacts connected with their disposal



Christoff Group, 2015 – Joburg waste summit
(Based on Eastern European countries)



(e.g. Metal concentration, Dissolved Organic carbon)

Background

Focusing on the **leaching behaviour** of the biostabilized wastes

Batch Leaching Tests (BLT)

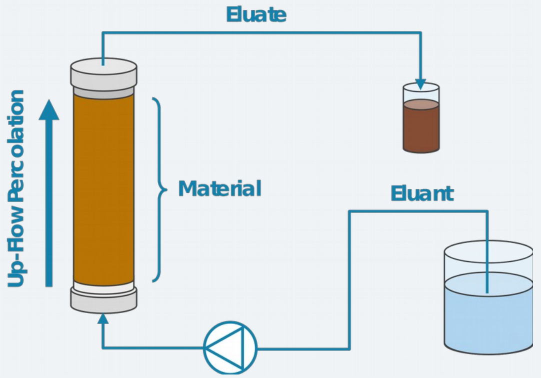
Advantages:

- Need only a small sample
- Relatively quick test (only 24h)

Disadvantages:

- Lack of information about release under dynamic conditions

Column Percolation Tests (CPT)



Advantages:

- Resembles quite well the field percolation conditions

Disadvantages:

- More expensive test
- More efforts for the operator

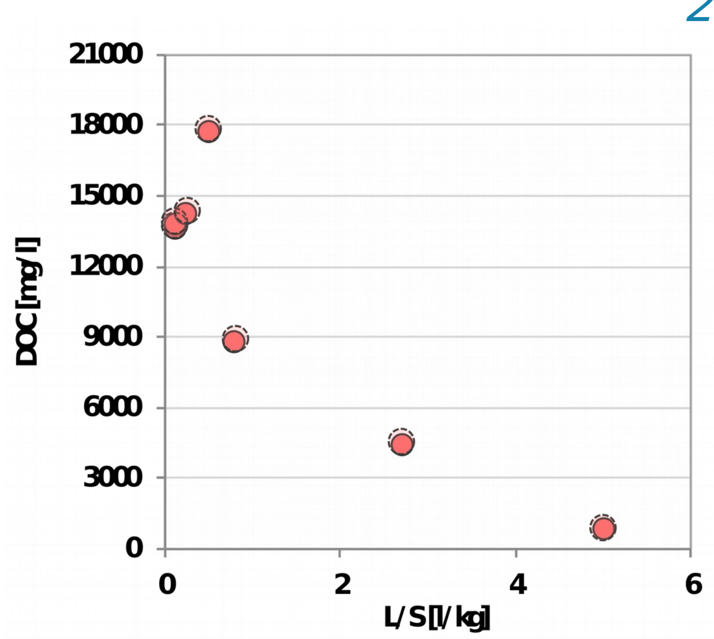
Aim:

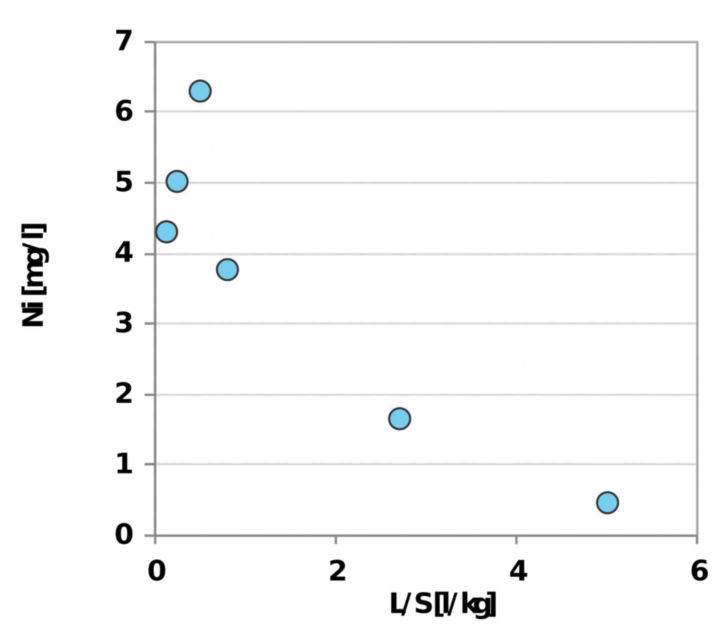
Elaborate a **screening tool** that can be used to evaluate in which cases the adoption of BLT or CPT is needed

DOC leaching pattern

In **organic-rich wastes** the **leaching pattern** of **dissolved organic carbon**

is very similar to the one observed for many **metals** *(Pantini et al., 2015)*

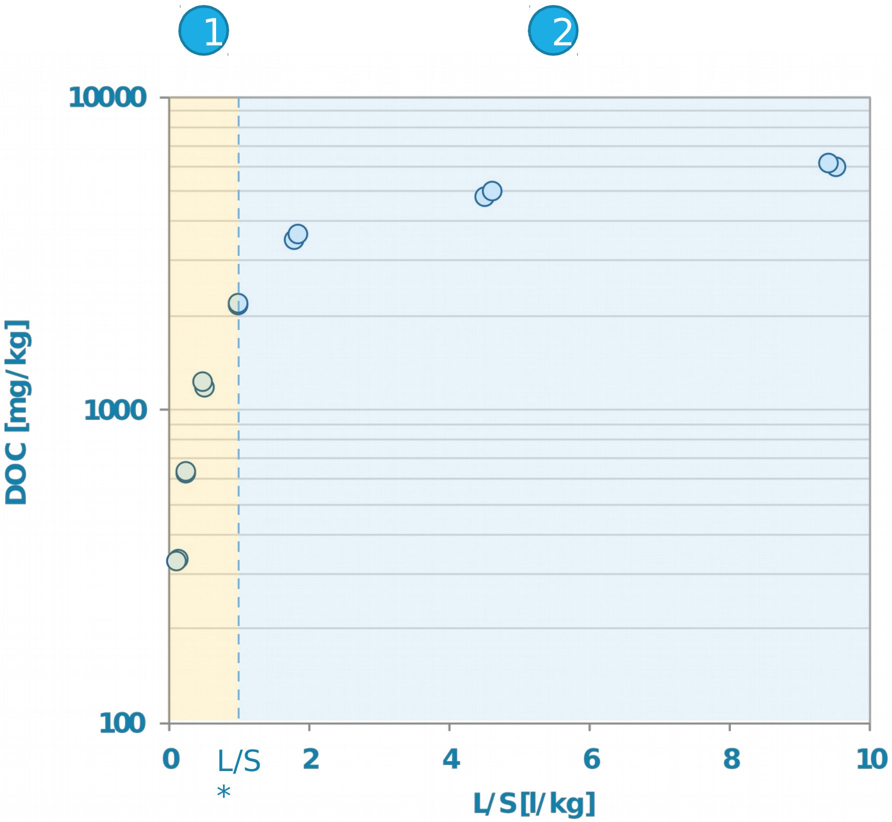




The metal release can be estimated by evaluating del leaching pattern of the DOC

DOC leaching pattern

For biostabilized wastes the **leaching pattern** of Dissolved Organic Carbon (DOC) can be related to L/S ratio



1 L/S ≤ 1

Release is more effective during the first period

2 L/S > 1

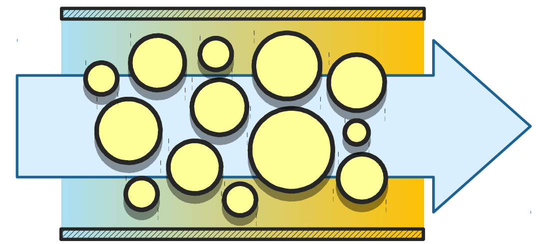
Release becomes slower for the rest of percolation

Modeling (DOC)

Cumulative **release of DOC** as a function of the **L/S ratio** and **Total Organic Carbon (TOC)**

1 **Flux-controlled** (L/S ≤ L/S*)

$$[DOC] = L/S \cdot \frac{TOC}{K_d}$$

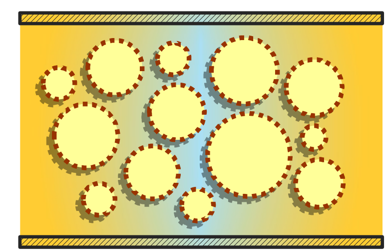


Concentration depends also on:

- the solid/water partition coefficient of TOC (**K_d**)

2 **Mass Transfert-controlled** (L/S > L/S*)

$$[DOC] = L/S^* \cdot \frac{TOC}{K_d} + 2\frac{TOC}{h_c} \cdot \left(\frac{D(t-t^*)}{\pi}\right)^{1/2}$$



Concentration depends also on:

- the solid/water partition coefficient of TOC (**K_d**)
- diffusivity of the constituent in water (**D**)

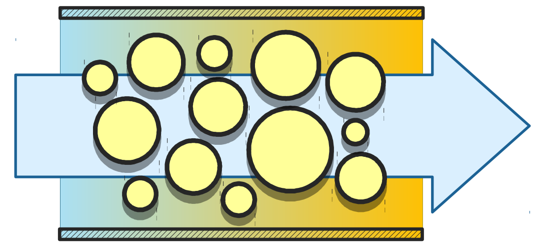
Modeling (Me)

Cumulative release of **metal** [Me] as a function of the **dissolved organic carbon** [DOC]

1 **Flux-controlled** (L/S ≤ L/S*)

$$[Me] = [DOC]\,K_{DOC,Me}$$

$[Me] =$



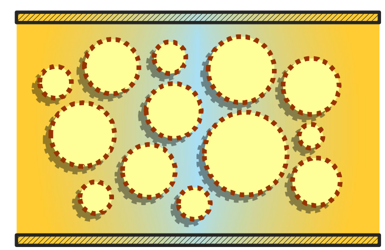
Concentration depends also on:

- the empirical partitioning coefficient between metal (Me) and DOC ($K_{DOC,Me}$)

2 **Mass Transfert-controlled** (L/S > L/S*)

$$[Me] = [DOC]\,K_{DOC,Me}$$

$[Me] =$



Concentration depends also on:

- the empirical partitioning coefficient between metal (Me) and DOC ($K_{DOC,Me}$)

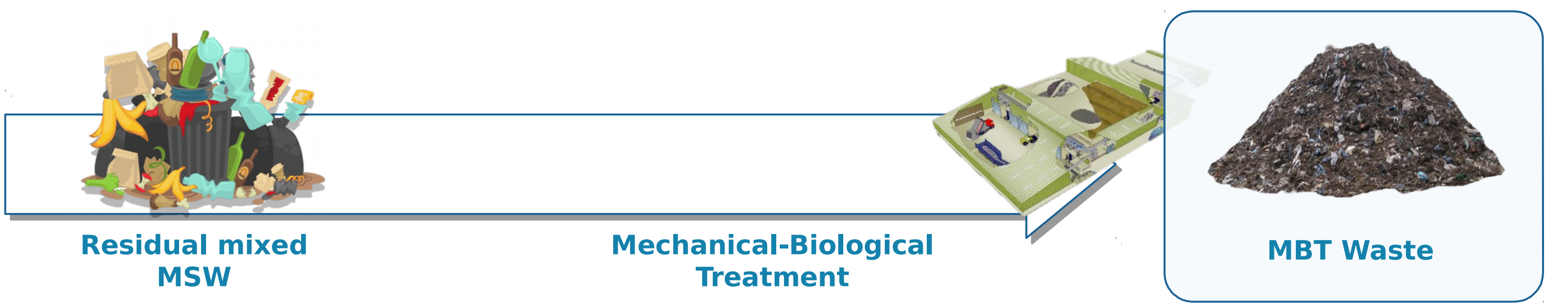
Derivation of partitioning coefficient: $K_{DOC, Me}$

By literature:

Data collected by **literature** about percolation of biostabilized **Municipal Solid Wastes (MSW)**

Source segregated organic wastes

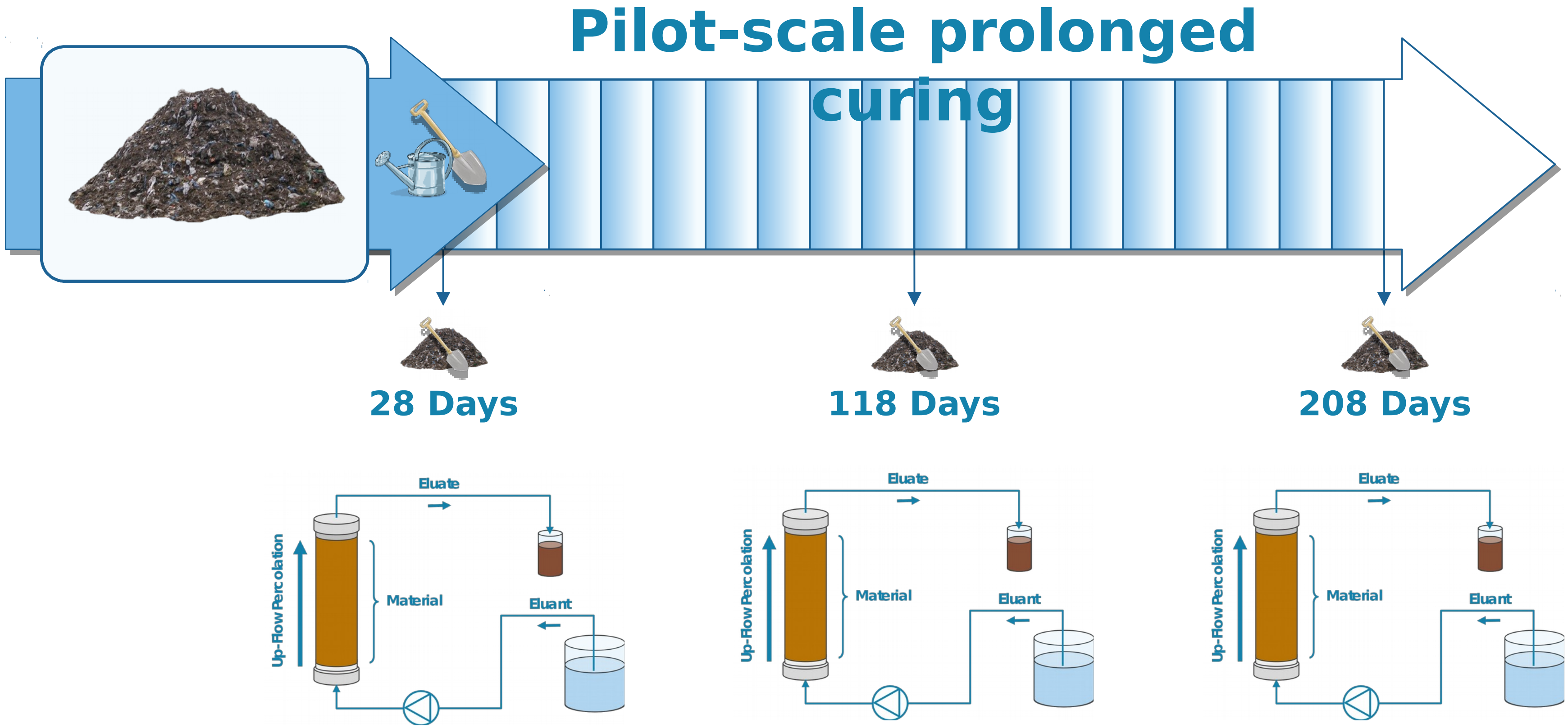
Residual mixed MSW



Derivation of partitioning coefficient: $K_{DOC, Me}$

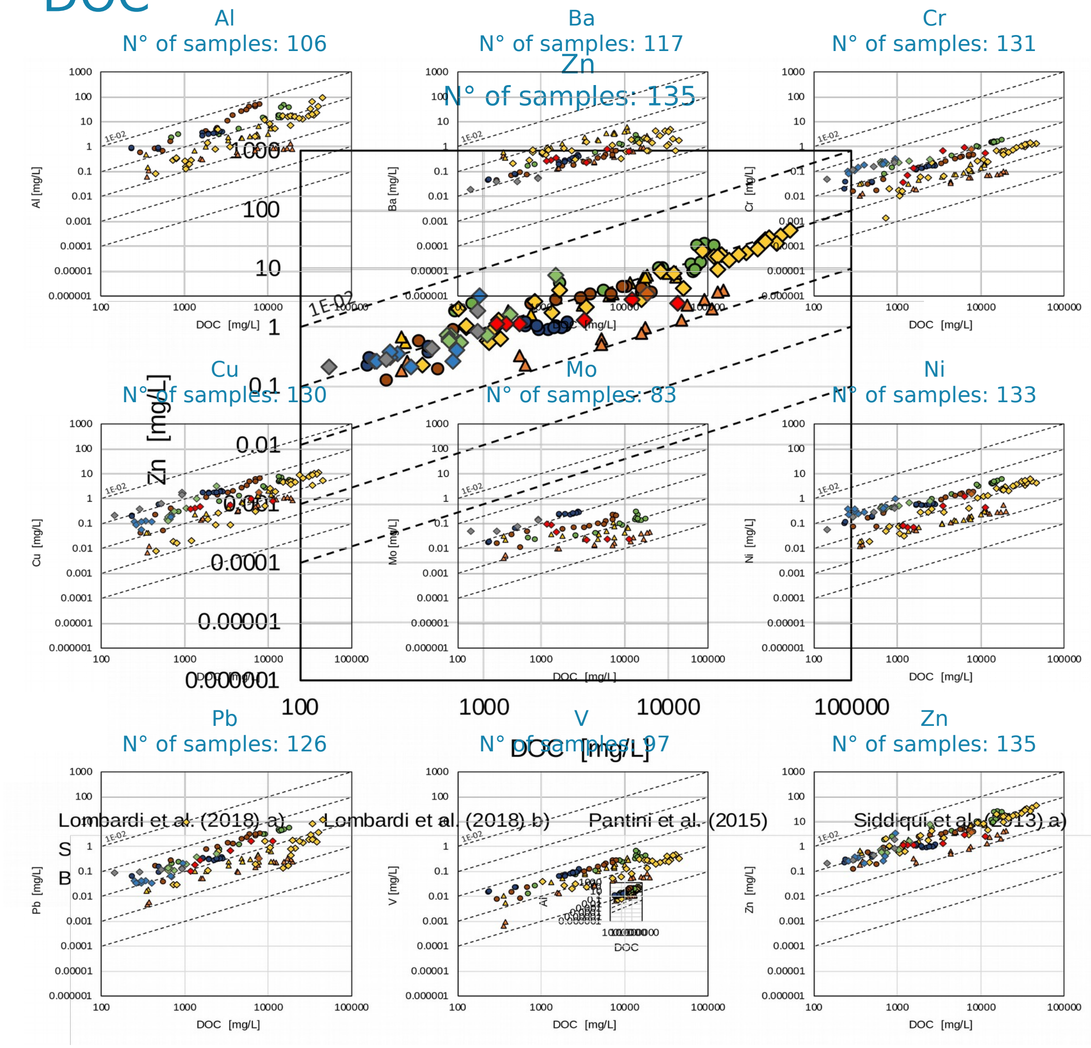
From experimental data:

Data collected from up-flow percolation tests on biostabilized **Municipal Solid Waste (MSW)**



Results

Empirical **correlation coefficient** between metal concentration and DOC



$$K_{DOC,Me} = \frac{[Me]}{[DOC]}$$

- Diagonal lines representing the metal to DOC correlation coefficients
- Almost all data fall within two consecutive diagonal lines

There is not a significant variability for the different coefficent

Results

Empirical **correlation coefficient** between metal concentration and DOC

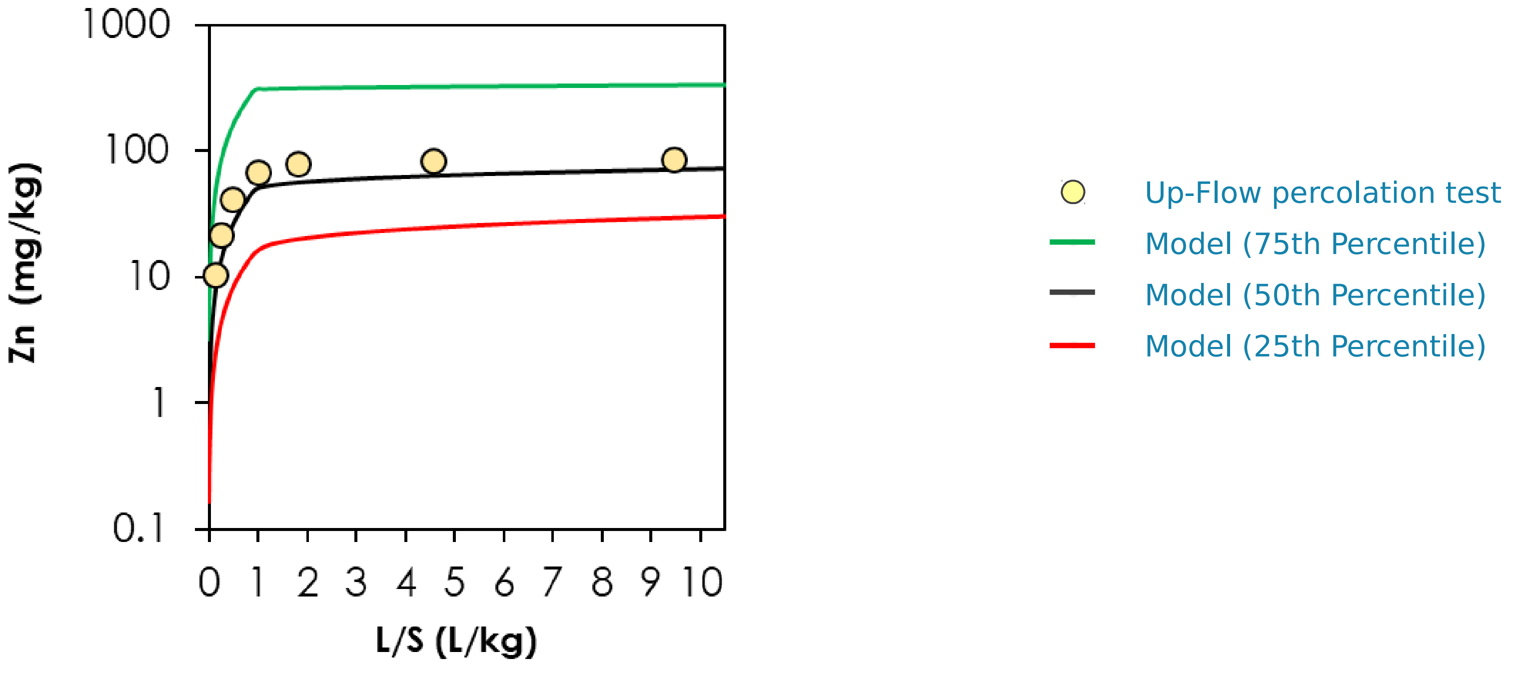
$K_{DOC,Me}$	Al	Ba	Cr	Cu	Mo	Ni	Pb	V	Zn
N° of samples	106	117	131	130	83	133	126	97	135
Lower range (25th Percentile)	4.0E-04	8.2E-05	2.6E-05	1.5E-04	7.7E-06	5.5E-05	5.5E-05	9.2E-06	5.6E-04
Median range (50th Percentile)	9.1E-04	1.5E-04	6.9E-05	2.9E-04	2.1E-05	1.7E-04	1.4E-04	2.4E-05	8.8E-04
Upper range (75th Percentile)	1.8E-03	3.7E-04	1.2E-04	5.7E-04	8.1E-05	3.7E-04	2.8E-04	3.6E-05	1.1E-03

Based on the correlation coefficient between metal concentration and DOC:

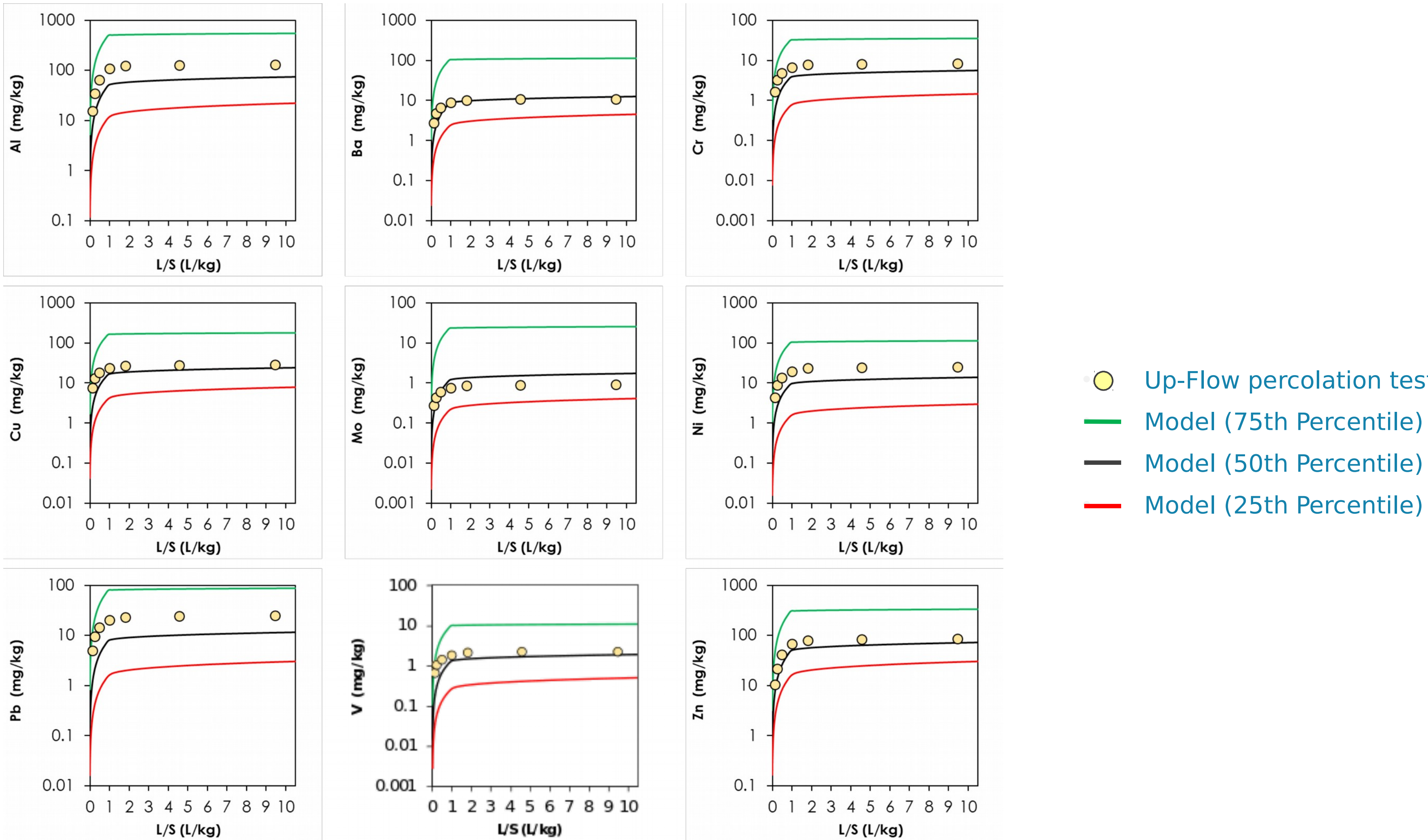
- The median (50th percentile) and the lower (25th percentile) and upper bound value (75th percentile) of the distribution of each metals to DOC correlation coefficient was calculated
- Relatively narrow variability (usually within one order of magnitude)

Results

Validation of the model by comparing the **cumulative mass release of BSW-28** and the results obtained using the **screening tool**



Results



- the approach proposed in this work anticipates quite well the leaching trend observed in the percolation column test (expecially for Cu and Zn)

Conclusions

The model results support our proposal to use TOC as a proxy for metal release:

- Data from different kind of biostabilization treatment lead to estimate generic correlation coefficient for the organic-rich wastes
- The model estimates quite well the experimental data of the up-flow percolation tests performed for this study
- Future research to refine the metal to DOC correlation coefficients

Thanks for your attention!

Alessio Lieto - *lieto@ing.uniroma2.it*

Department of Civil Engineering,
University of Rome “Tor Vergata”