Modelling dissipation of Chlordecone in soils
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Chlordecone: insecticide against Cosmopolites sordidus

Applied in banana fields between 1972 and 1993, 3 kg ha\(^{-1}\) year\(^{-1}\)

Stable and persistent organochloride, high hydrophobicity, low solubility, \(K_{oc} = 17.5 \text{ m}^3 \text{ kg}^{-1}\)

10 years after: contamination of water (\(\geq 10 \mu\text{g L}^{-1}\)) and vegetables (\(> 1 \text{ mg kg}^{-1}\))

Question: persistence duration?

Three steps:

- « Space for time » approach of current contamination
- Modelling leaching and resulting contamination of soils
- Measuring runoff and drainage water contaminations for validating the model

Ecotrons & Lysimeters
Nancy, France
March 29-31 2010
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« Space for time » approach of current contamination

A set of 35 banana parcels, including diverse levels of intensification, located on three main soil types: andosol, ferralsol, nitisol (Clermont-Dauphin et al, Agr. Ecos. & Env., 2005)

Survey: reconstituting the chordecone supply schedule

Soil sampling:

- Accounting spatial position and variability
- Determining CLD and SOC content and BD on 0-10, 10-30 cm and deeper layers

Result: multiple regression of CLD soil content against CLD supply, SOC, and annual rainfall average: more than 80% of variance was explained, without accounting time

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WISORCH : a dissipation model of chlordecone in soils
West Indies ORganoCHlorids  Cabidoche et al, Env. Pol., 2009

Hypothesis : only leaching is responsible for chlordecone dissipation, no degradation occurs

Content

- Annual step
- First order kinetics applied to each supply $S_i$
- $S_j$: remnant CLD soil content at the end of year $j$
- High sorptivity on carbon content ($S_{soc}$): $K_{oc} = 17.5 \text{ m}^3 \text{ kg}^{-1}$
- Two drainages are applied: concentrated drainage resulting from stem flow the first years ($D_{red}$), then drainage calculated from hydric balance ($D_{bil}$)

Validation or Calibration?

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Using leaching outputs for validation

Modelling average CLD concentration in drainage water at the bottom of A layer:

\[
[CLD]_w = \frac{(S_j - S_{j-1})}{D_j}
\]

source of B layer contamination

2 submodels applied on a 2-layer soil:

- Matric drainage below the interrow (MD)
- Dual drainage below banana stem (DD)

Wick Lysimeters
Distributed drainage \(\Rightarrow\) multiple lysimeters

Using HYDRUS2D to simulate lysimeter drainage flows

Removing lysimeters from the model \(\Rightarrow\) no bias affecting lysimeters

Measuring [CLD] in water samples

Sansoulet et al., EJSS, 2007
Sansoulet et al., Vadose Zone J., 2008
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Lysimeters:

2 \([\text{CLD}]_w\) (regression slope) phases below banana in andosol

- First corresponds to MD
- Second to DD

WISORCH model is in good accordance with measured \([\text{CLD}]_w\) while taking calibration values of Koc: 19.8 for andosol, and 2.7 m³ kg⁻¹ for nitisol

\(\Rightarrow\) Koc differences between andosol and nitisol are actual
Discussion and conclusions

- WISORCH, a simple leaching model, accounts for chlordecone dissipation in soils of the FWI
- The validity of WISORCH indicates that no chlordecone degradation occurred
- It allows temporal extrapolation of chlordecone pollution duration: several decades for nitisol, more than half millennium for andosol
- Even if depollution is faster in nitisol, contamination hazard for drainage water and crops is currently higher
- Determining soil CLD content is not sufficient for predicting water and crop contamination
- Research is currently conducted for understanding why sorptivity of allophanic andosol and halloysitic nitisol are different

Thanks for your attention