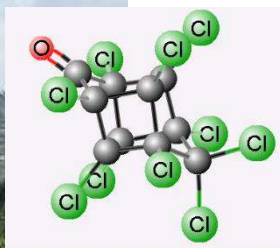


Persistence of pesticides in the environment: impacts and strategies

The case of chlordane in French West Indies



Magalie Lesueur Jannoyer,
Philippe Cattan,
Charles Mottes,
Lai Ting Pak,
Thierry Woignier



WORKSHOP

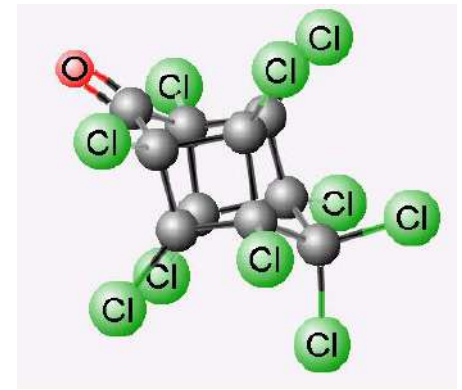
Reducing the use
of pesticides
in tropical agriculture:

key challenges
and strategies

11-12 October 2021
Agropolis International
Montpellier



Context of pollution by chlordecone (CLD, $C_{10}Cl_{10}O$)



- POP insecticide (organochlorine)
 - Physicochemical properties:
 - **low solubility in water** ($S < 3 \text{ mg/L}$),
 - **high affinity for organic matter** ($\log K_{oc} > 3,5$)
 - **Poor-low biodegradability** related to its peculiar chemical structure (bishomocubane) with high steric hindrance (half life 4 - 45 years).
 - ▶ **Long term pollution**
 - ▶ **Natural soil decontamination would take decades / centuries**

(Cabidoche et al, Environ. Pollution, 2009)

- intensively used in banana cropping systems (1971 → 1993) in French West Indies
 - Heterogeneous powder application
 - ▶ **Heterogeneous soil pollution**
 - ▶ **Diffuse pollution**

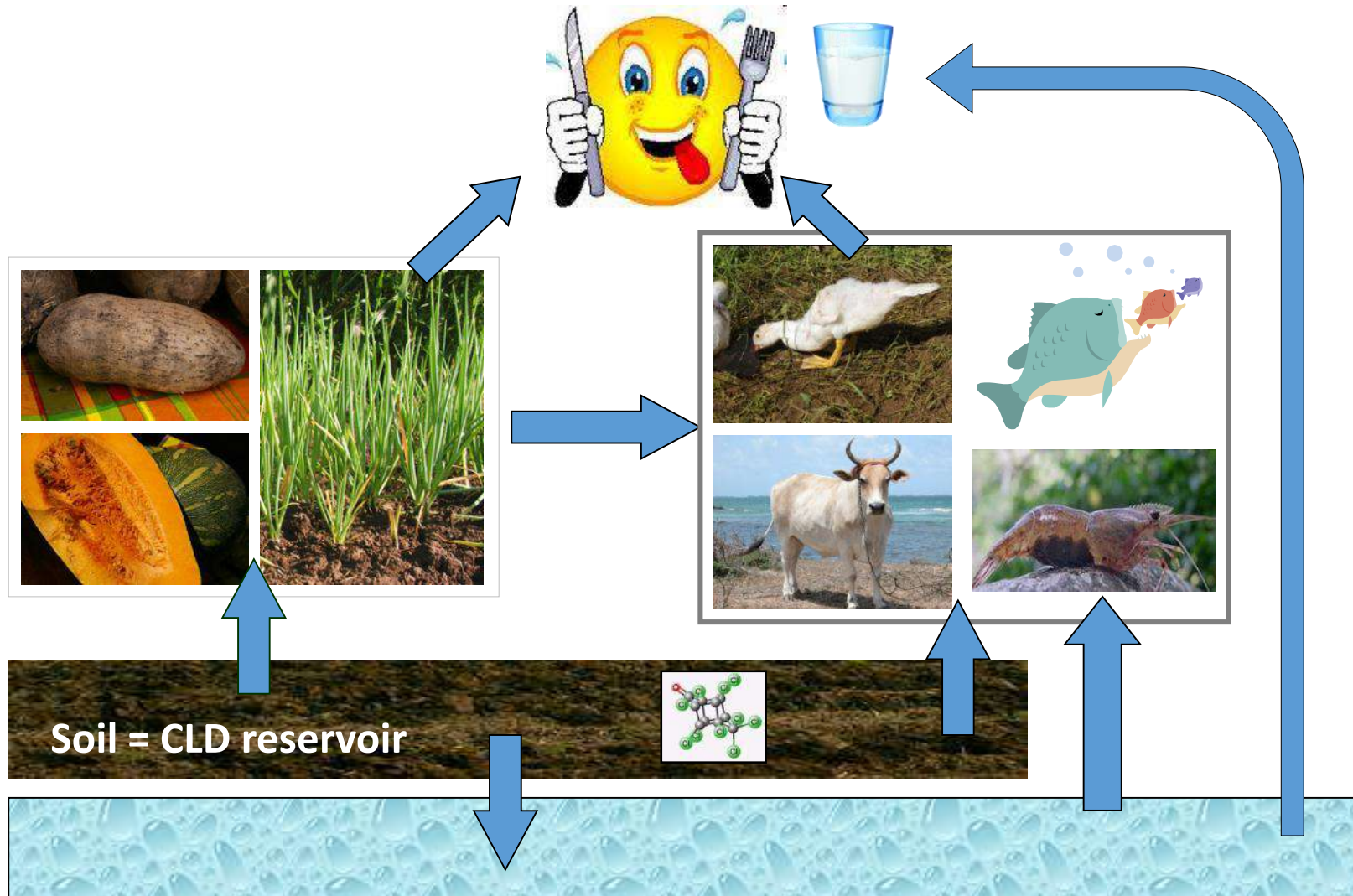


Long term pollution:

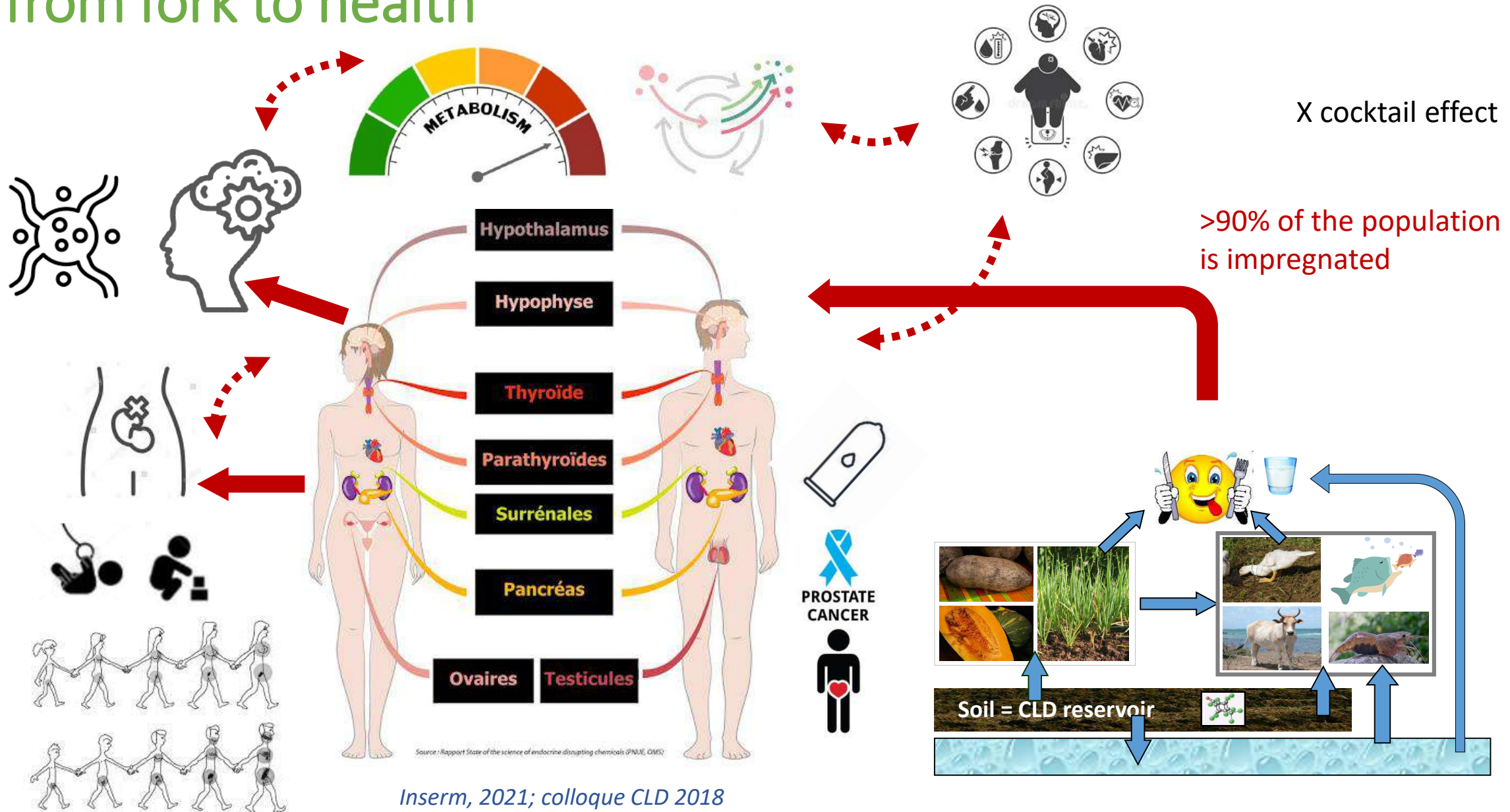
- What does it means?
 - pesticide **pollution** = not « visible/ tangible »
 - **Long term** = Does not appear quickly after application
 - The question of **measurement** and **time** is crucial...in the processes
 - **New approach** to characterize the problem and the impacts
 - Where it is? For how long?
 - What kind of sanitary impacts? At what time scale? which compartments? Who?
 - How to remediate?
 - Simple questions, not so simple answers, not so easy to anticipate...
→ a National action plan
- Need to new knowledge...
 - To design **new complementary tools**
 - Dynamic and spatial tools
 - In a **systemic and interdisciplinary approach**
 - At all scales (space and time)
 - including all environmental compartments



CLD impacts food chains and environmental compartments: from soil to fork



CLD impacts food chains and environmental compartments: from fork to health

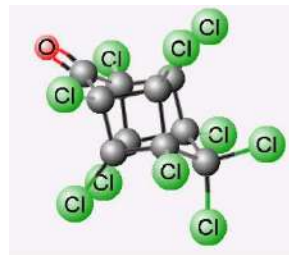


CLD remediation, similar aproach

Properties?
Impacts?



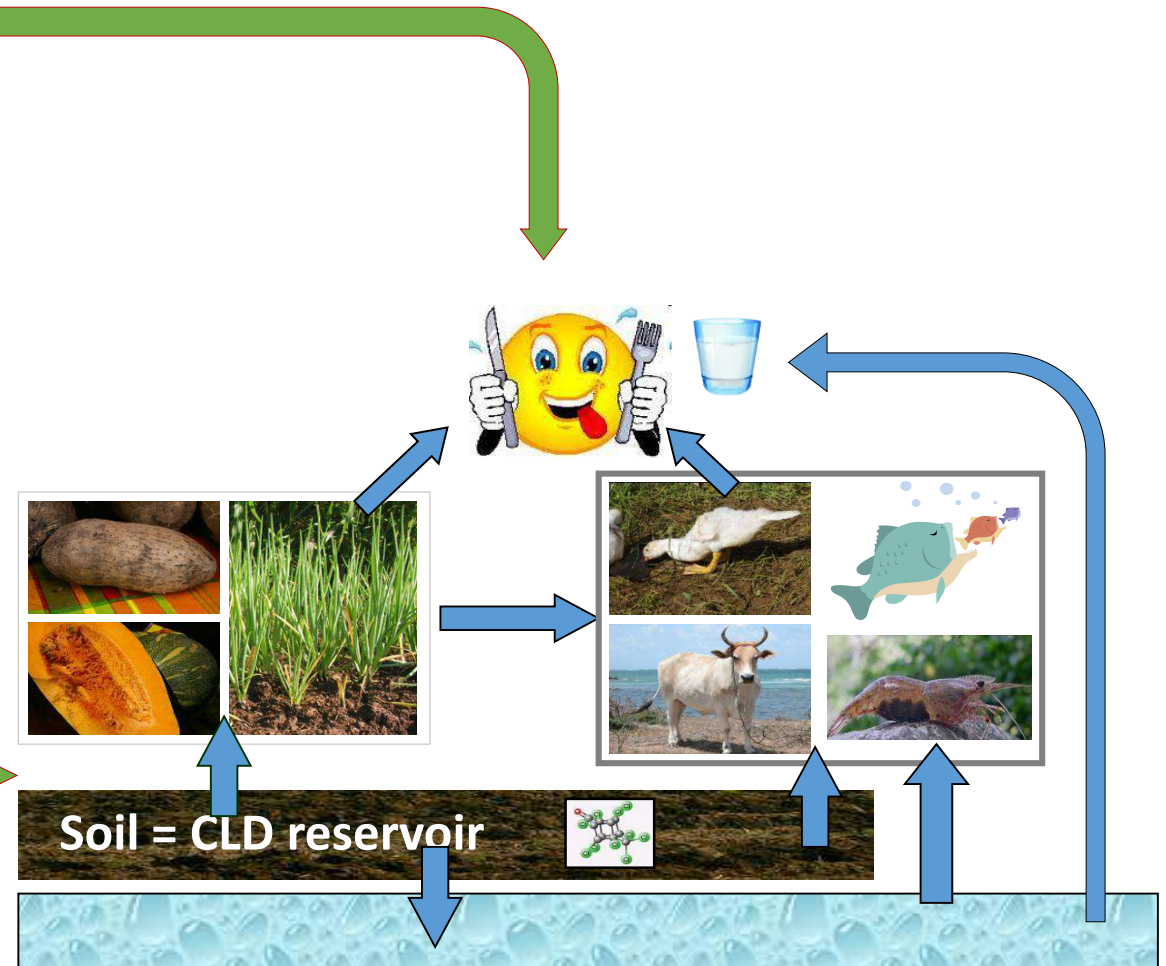
Access?
Efficiency?



x



x



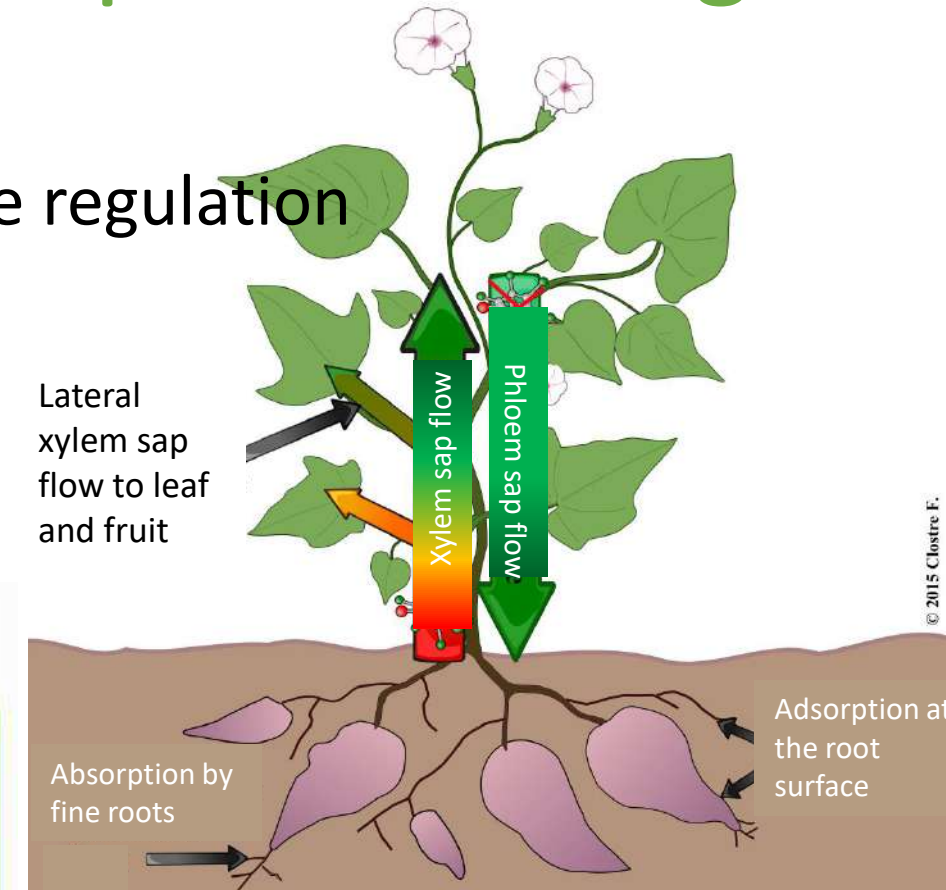
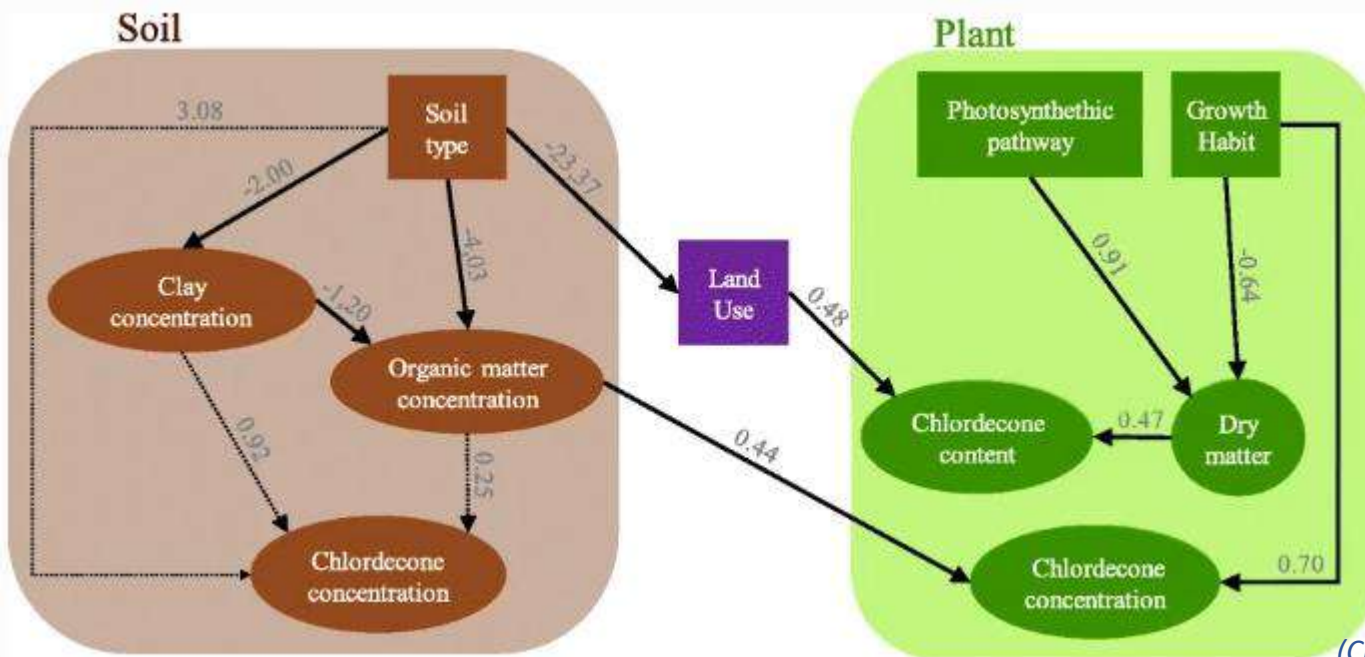
How to reduce population exposure through food?

- Fruits and Vegetables comply with the regulation
 - Generic knowledge on passive transfer

CLD : **soil** > **root** >> stem > leaf

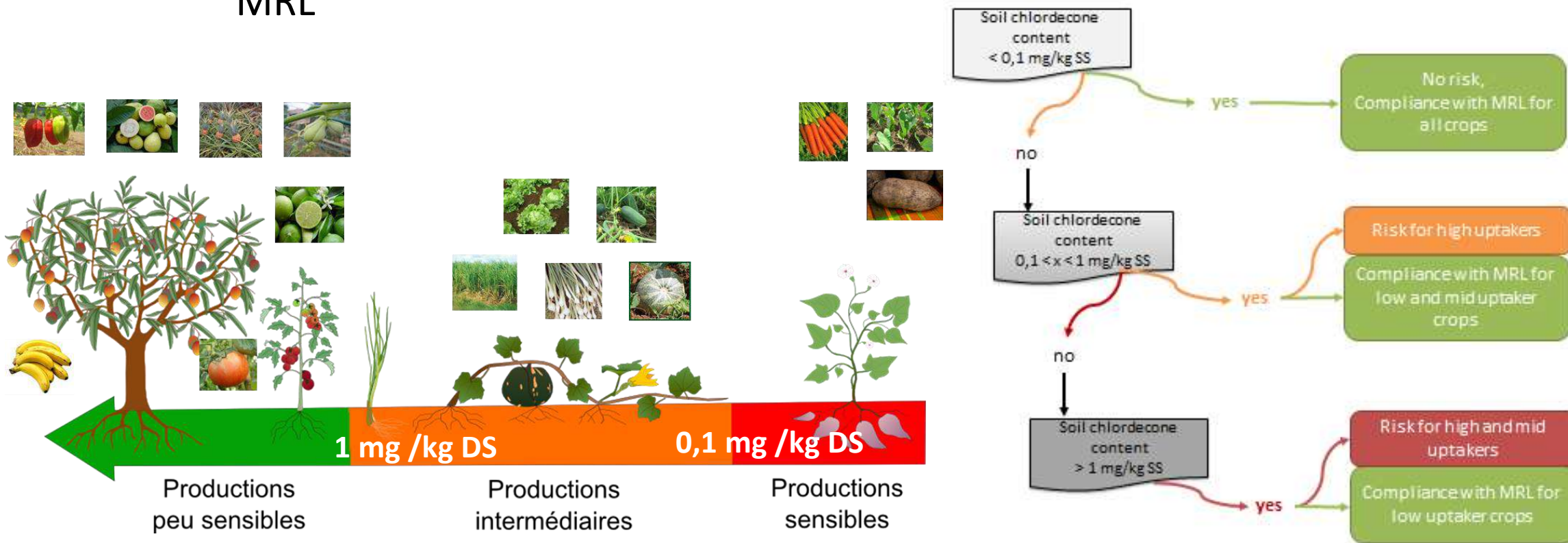
↑ ↑

fruit fruit



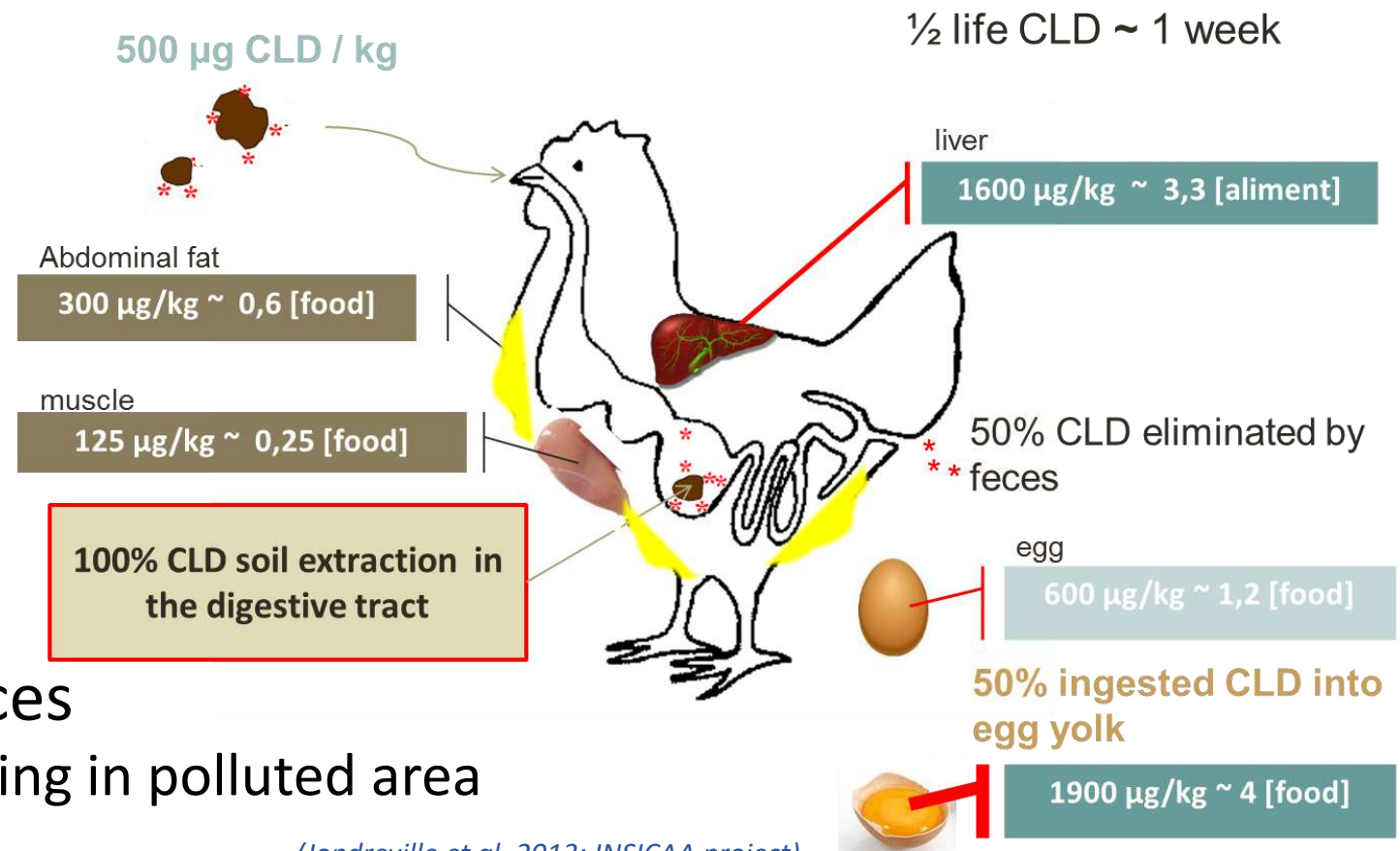
How to reduce population exposure through food?

- Fruits and Vegetables comply with the regulation
 - Management tool according to soil CLD content and MRL



How to reduce population exposure through food?

- Still a challenge: animal products compliance
 - Bioaccumulation and excretion
 - Traceability?



- Evolution of practices
 - Confinement farming in polluted area

(Jondreville et al, 2013; INSICAA project)

Characterization of the pollution levels and processes

- New analytical technologies

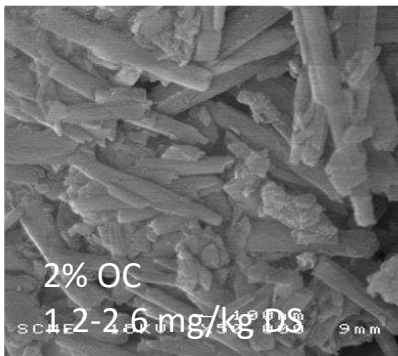
- quick and less expensive to answer to the demand and for different matrices
- NIRS, SPME, ...



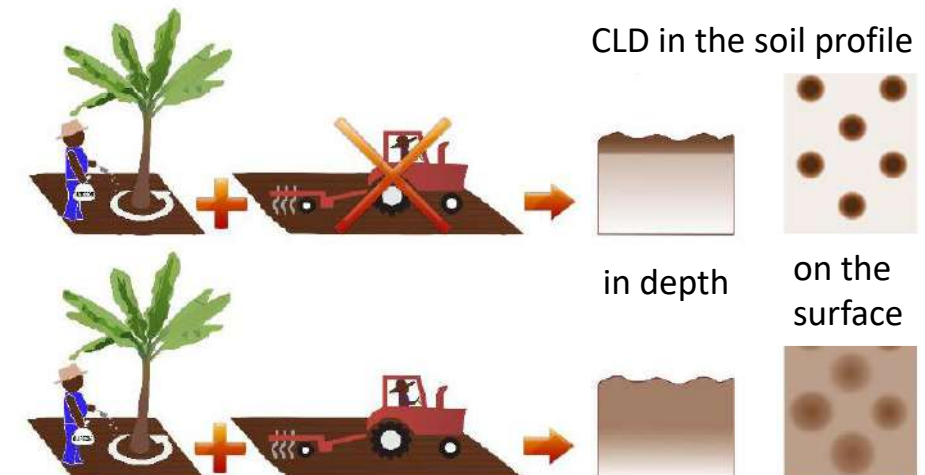
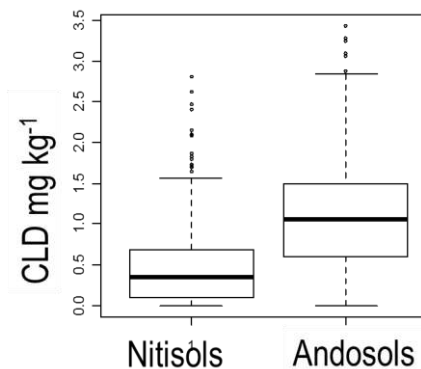
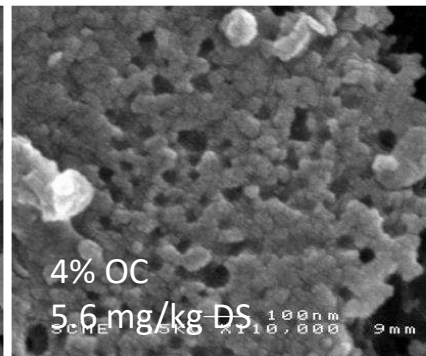
- New sampling method (heterogeneous pollution) *(Clostre et al, 2014)*

- Soil: spatial variability according to soil type and practices *(Clostre et al, 2014)*

Non allophanic soil

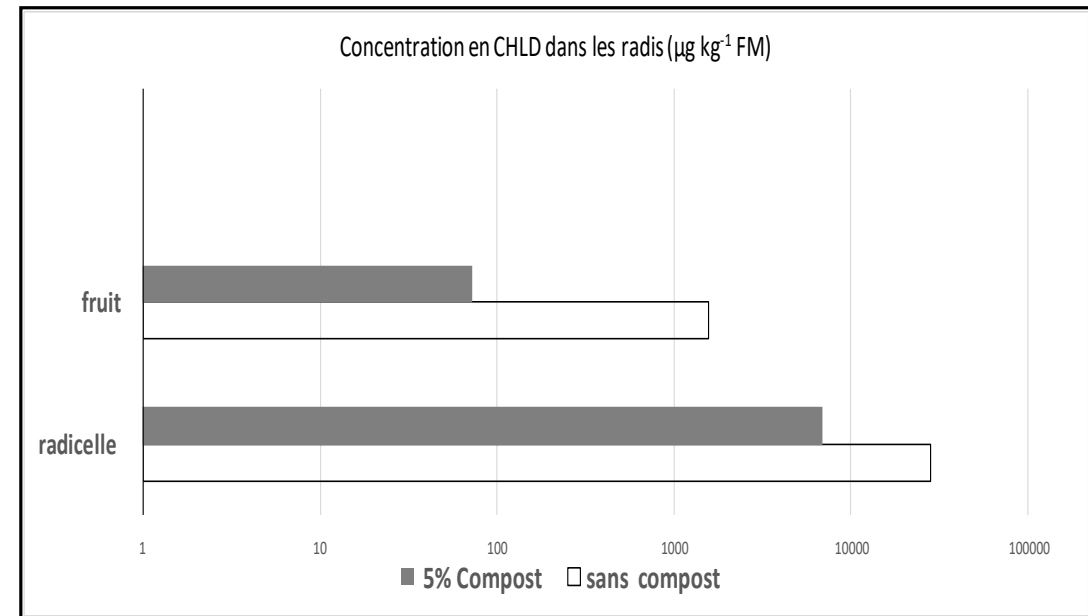


Allophanic soil



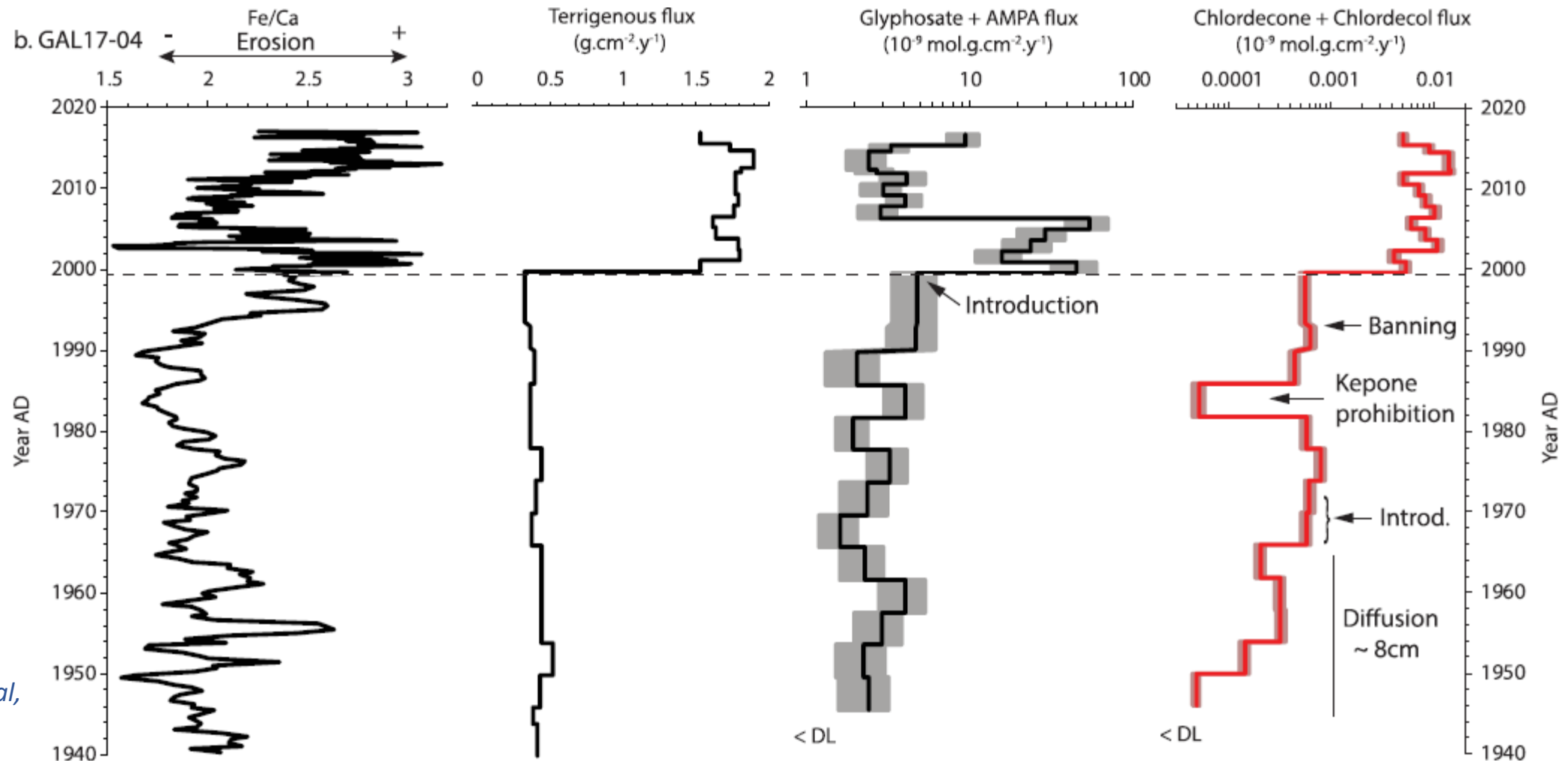
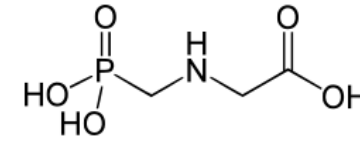
Characterization of the pollution levels and processes

- Practices can modulate pollution transfer
 - OM amendment traps CLD in soil = physico-chemical effect
 - Reduction of CLD transfer to water and crops
 - ✎ 5 fold water transfer
 - ✎ 2-4 fold plant disponibility
 - More efficient for andosol (allophanic clays)
 - Not perennial, but common practice, easy to implement
 - Intermediate option



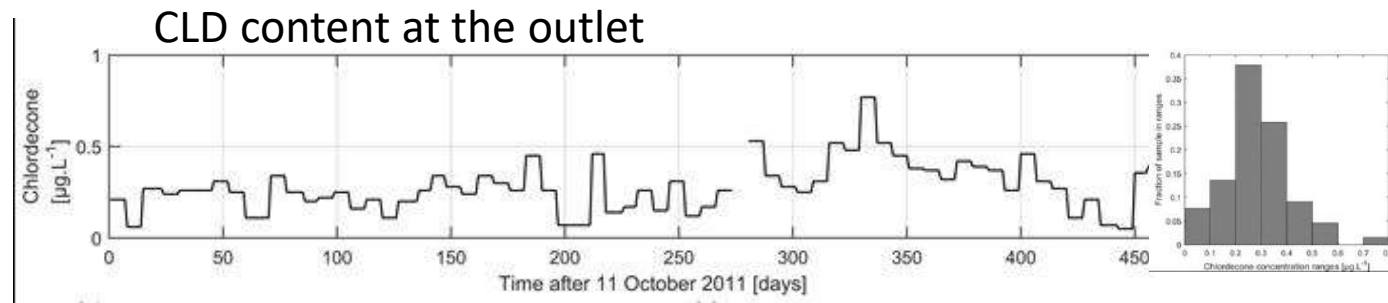
Characterization of the pollution levels and processes

- Practices can modulate pollution transfer
 - Glyphosate** increases erosion and CLD fluxes



Characterization of the pollution levels and processes

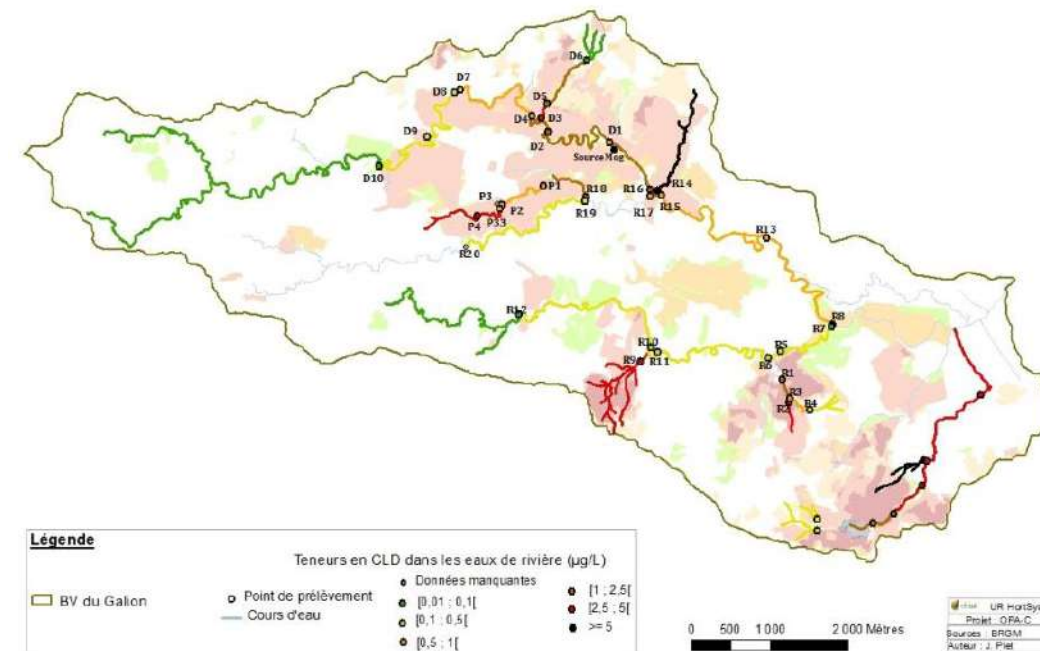
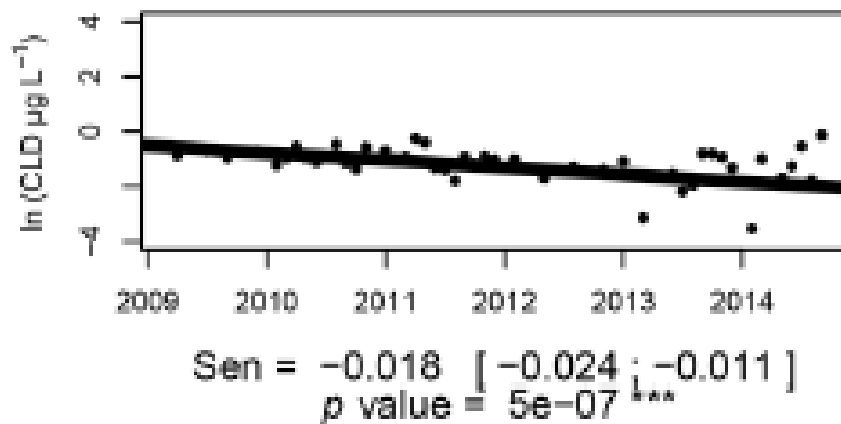
- Water: spatial and temporal variability



CLD content at the watershed scale

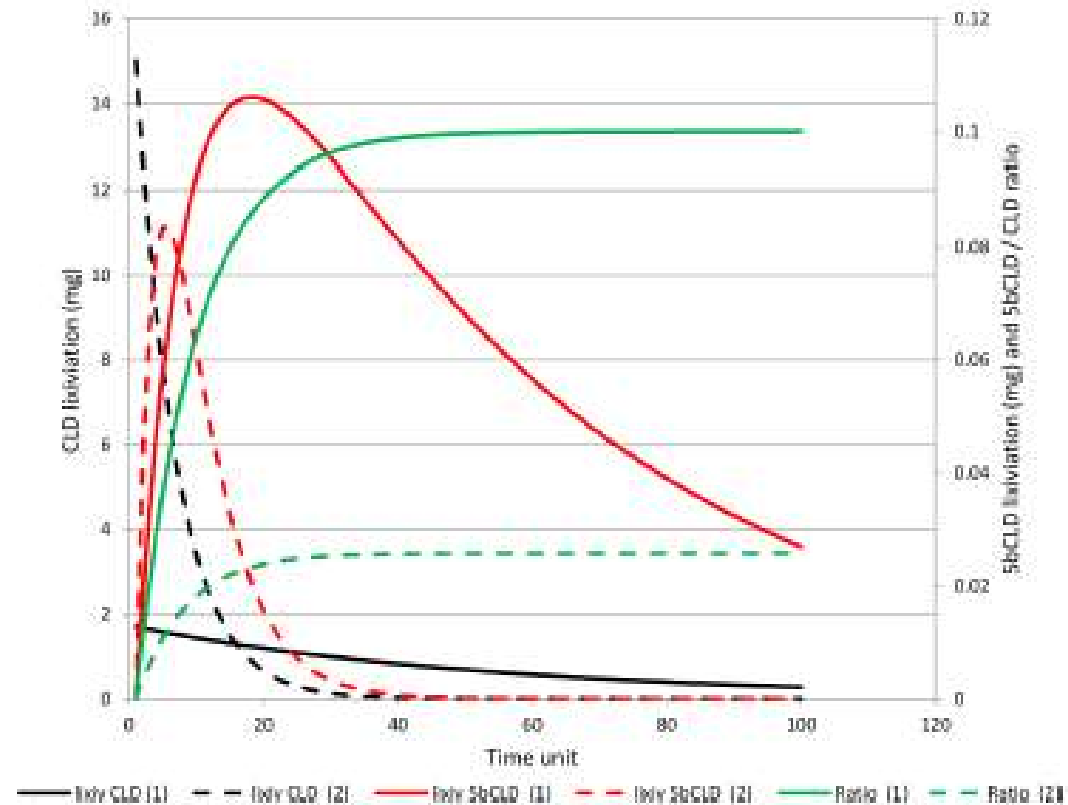
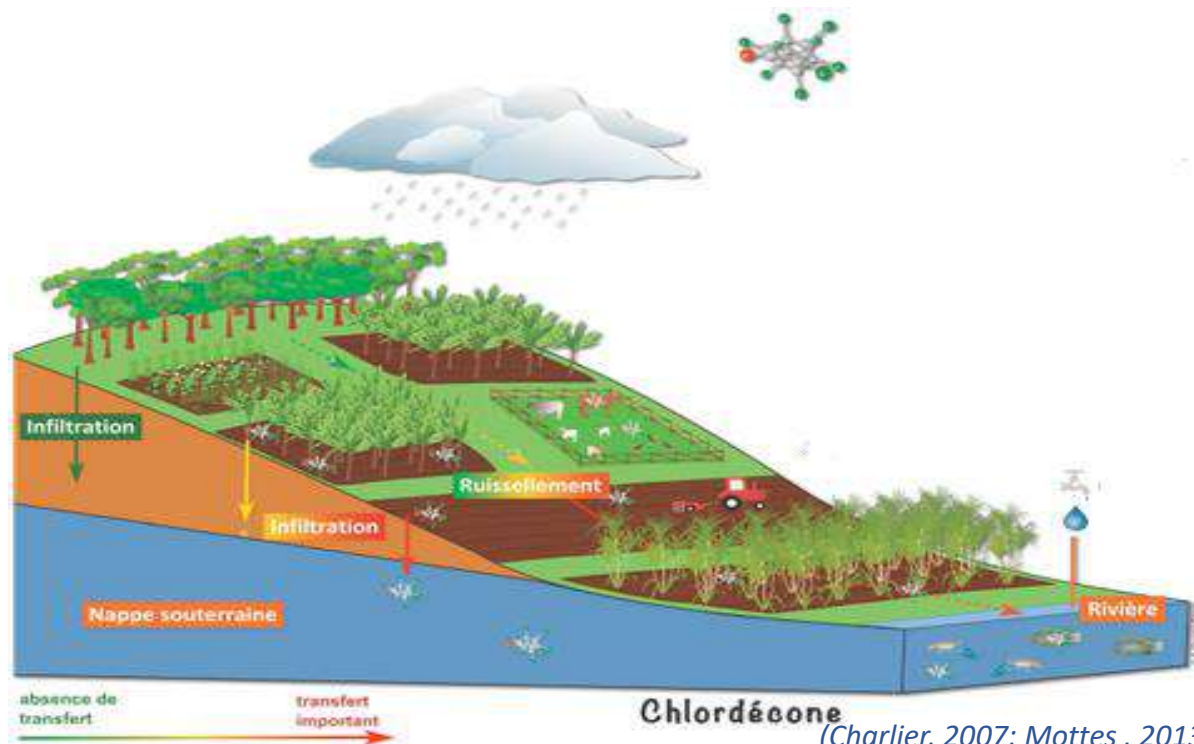
(Della Rossa et al, 2017, Mottes et al, 2017, Cattani, 2019)

0.1 to present ; Andosol ; AEP - Vive - CApot



Characterization of the pollution levels and processes

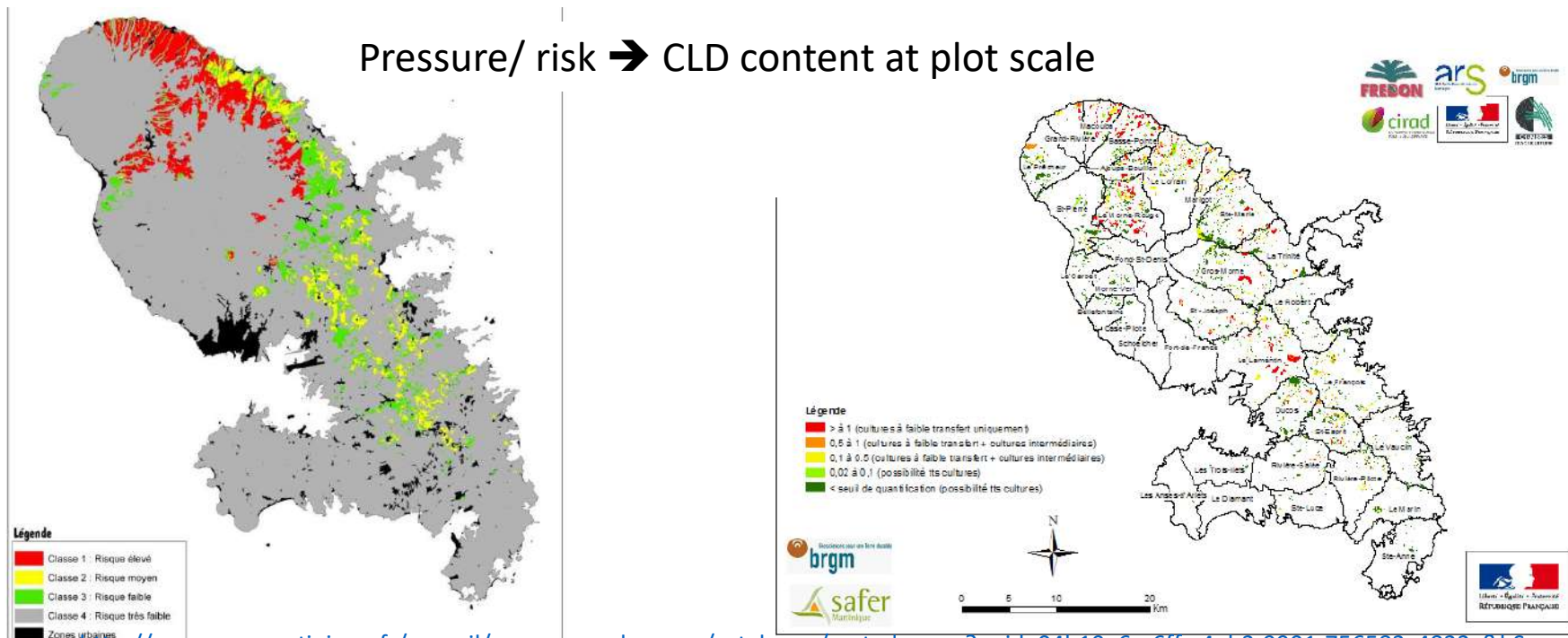
- New knowledge:
 - Pollutant transfer in tropical area and interactions with agricultural practices
 - Long term pollution processes



(Charlier, 2007; Mottes, 2013; Pak, 2013; Cattani et al, 2019)

Characterization of the pollution levels and processes

- Capitalisation and data sharing
 - Still a very sensitive issue
 - Mapping of the polluted fields
 - Modelling and transfer simulations (*Cabidoche et al, 2009; Charlier 2007, Mottes et al 2015, Cattan et al, 2019*)

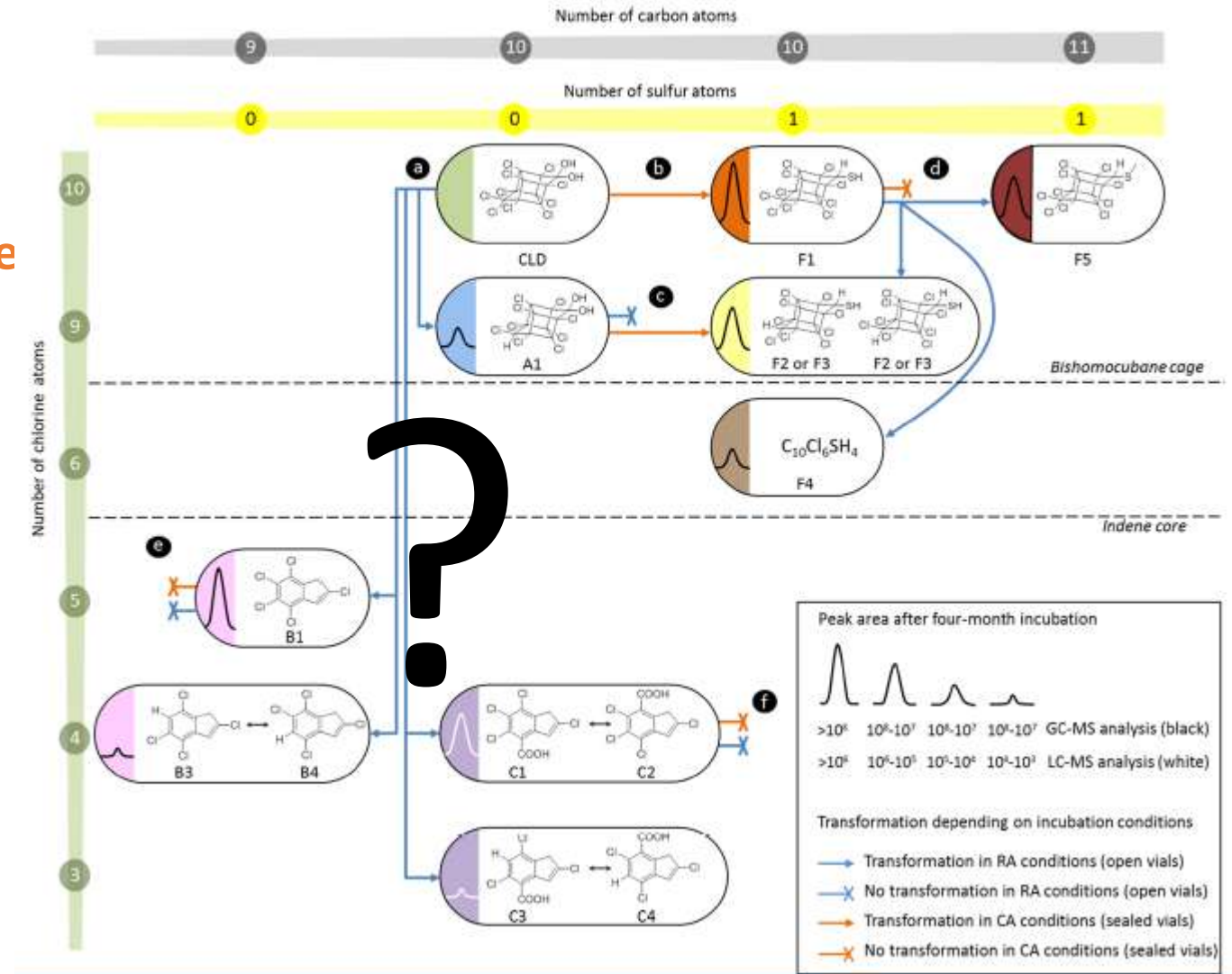


What about CLD decontamination?

- About more than **20 000** ha polluted at different levels

► Need for efficient cost-effective in situ treatments.

- New insight with new expectations, even if bio-degradation is not complete (*Chevallier, 2017; Chevallier et al, 2019; Della Negra et al, 2020*)



To conclude

- **One health approach**: holistic approach with interdisciplinary research to
 - co-design a global representation of the processes and potential impacts with **all stakeholders** (narrative maps)
 - find appropriate solutions/policies at different scales
 - Individual
 - Product
 - Territory
 - ...
 - **Strengthen knowledge and fight against false idea and fake news!**
- Support **agroecological systems**, especially on non polluted fields



We acknowledge.....

- French National Research Agency (Chlordexco project)
- French Ministry for Overseas Development (MOM project)
- EU-FEDER research funds
- Water Office of Martinique
- National Action Plan

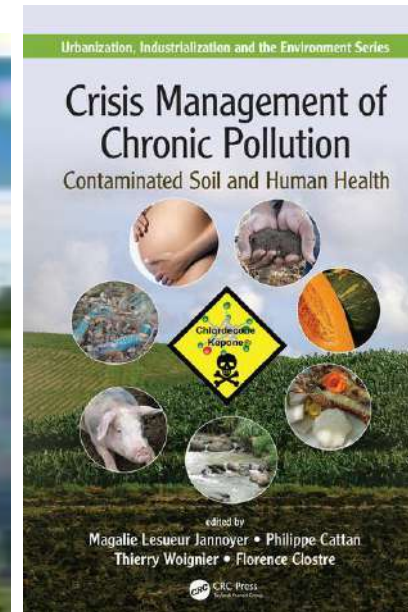


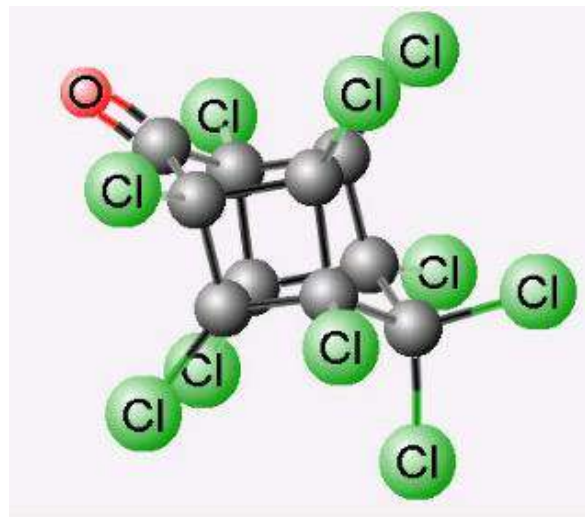
for supporting this pluriannual research program

- For synthesis and perspectives :

<https://www.crcpress.com/Crisis-Management-of-Chronic-Pollution-Contaminated-Soil-and-Human-Health/Jannoyer-Cattan-Woignier-Clostre/p/book/9781498737838>

<https://link.springer.com/journal/11356/volumes-and-issues/27-33>



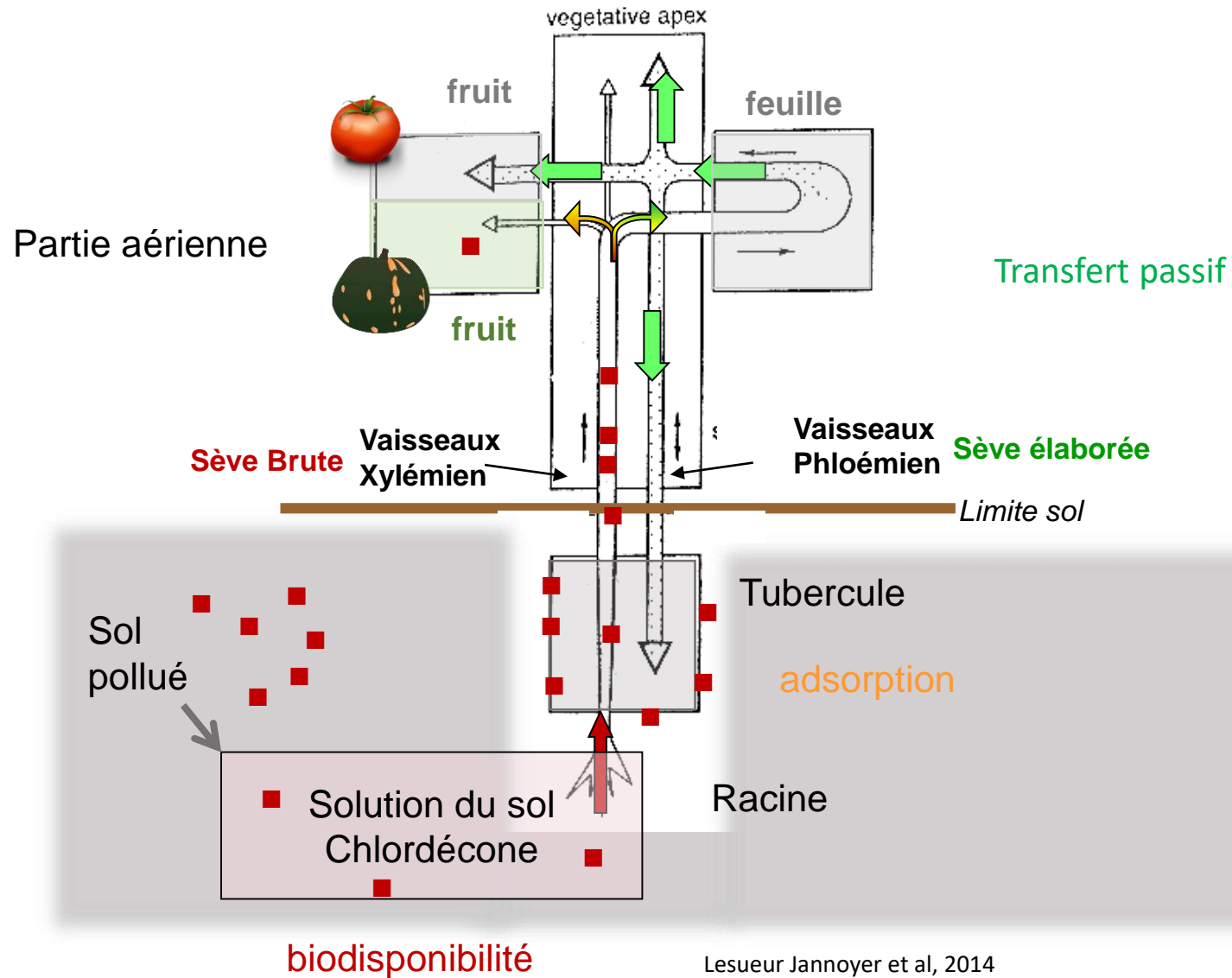


Thanks for your attention,
any questions?

Contact: jannoyer@cirad.fr

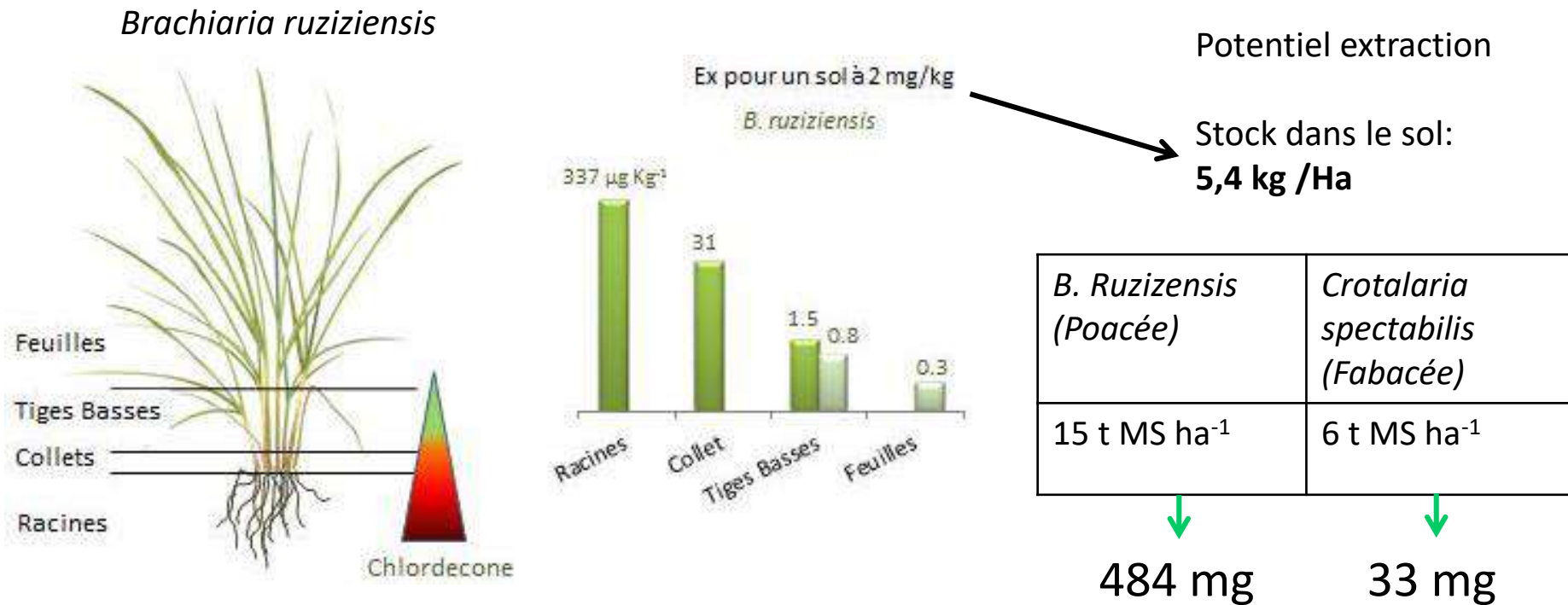


Plant contamination: a conceptual model



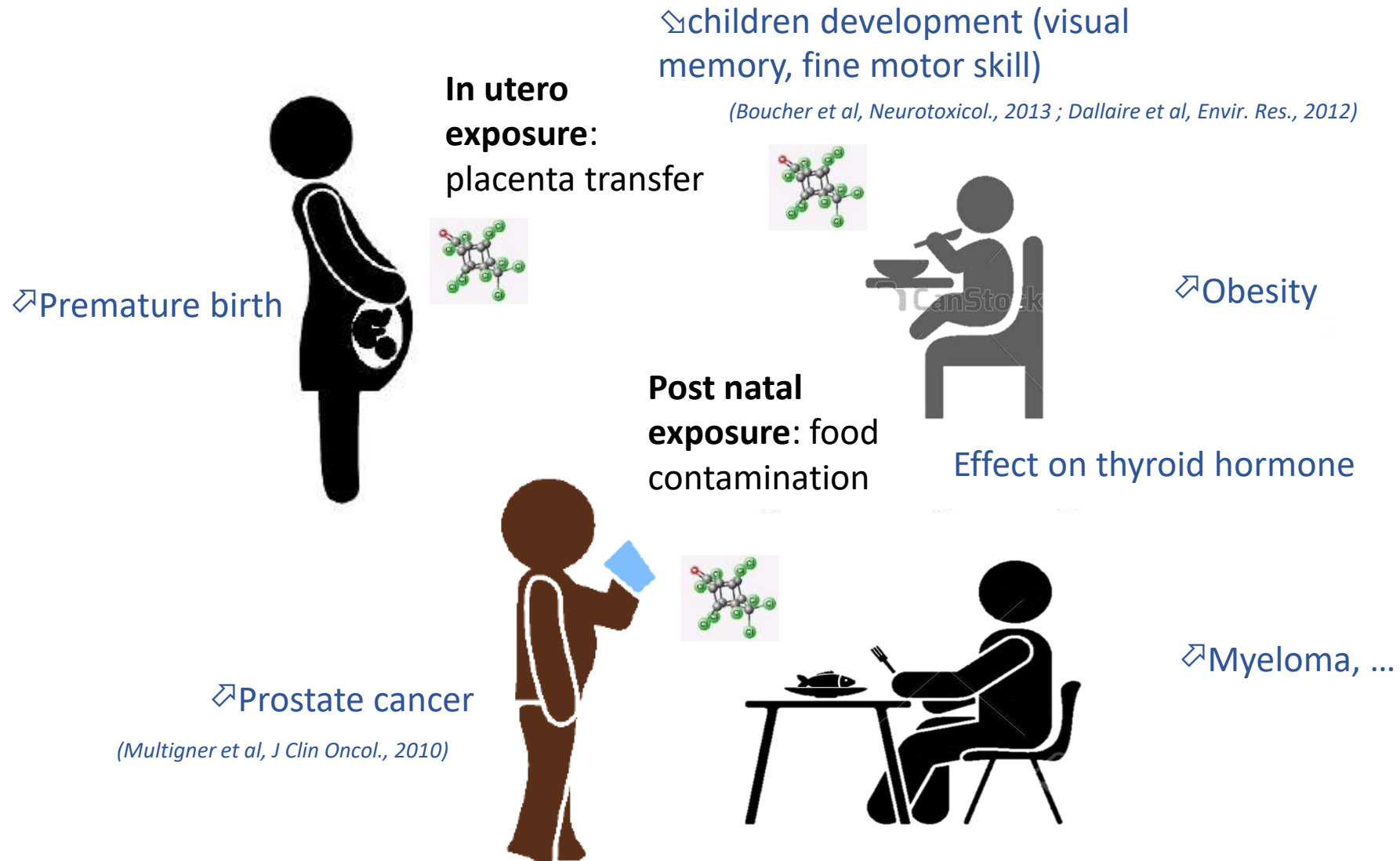
Phyto-extraction

Peu d'espoir avec les plantes cultivées explorées

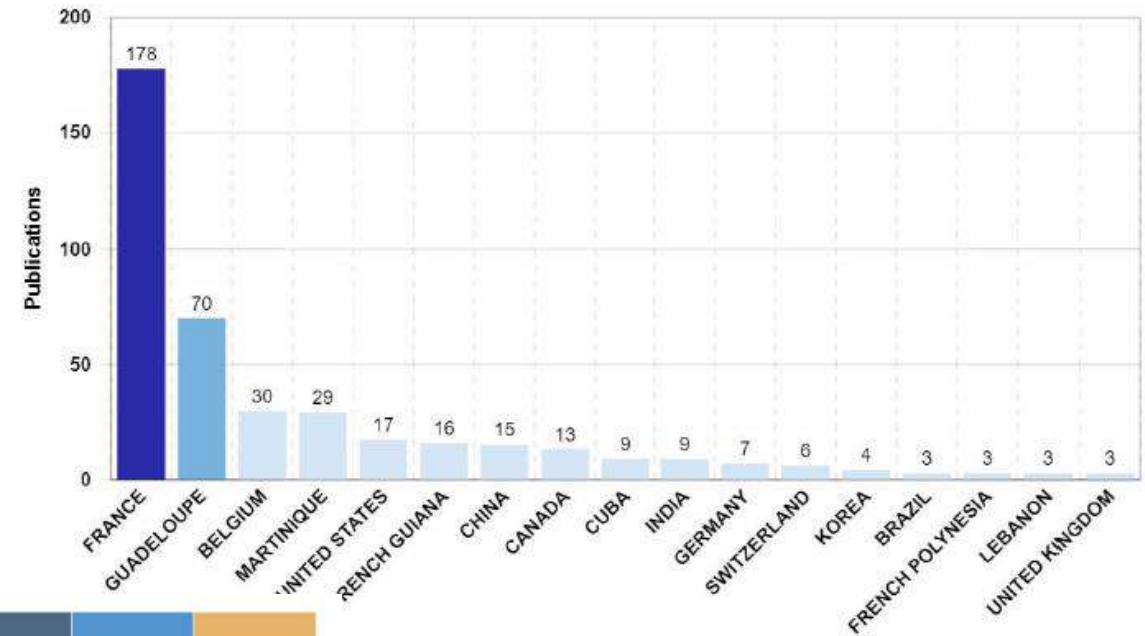
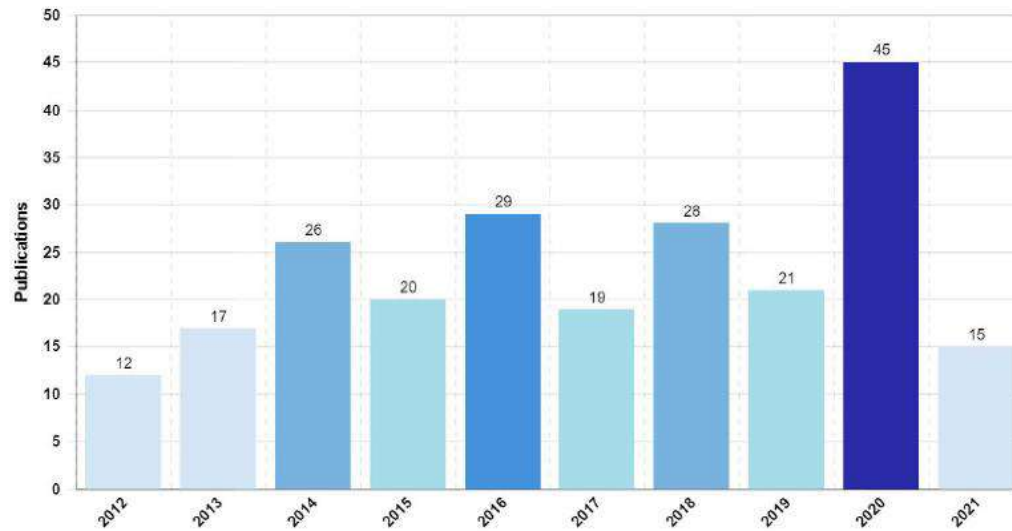


Quelle filière de traitement?

Exposure and health impacts: all the population is impregnated



Publications



Box size Indicates Web of Science Documents ①

WoS, 1980-2021

Priorities of action: a National Action Plan

- To **reduce the population exposure and improve the knowledge on health impacts**
 - According to new regulation (UE Maximum Residue Limit)
 - According to the food contribution
 - Water pollution management
 - Soil to plant transfer and management tool
 - Bioaccumulation assessment for animal products
- To **characterize the pollution** in the environmental compartments
 - Where? -> which compartment? What process?
 - How much? -> how to measure?
 - For how long? -> how to evaluate?
- To **find solutions** of decontamination and remediation
 - Which compartment?
 - Which conditions?

