A socio-scientific approach to develop synergies between research and teaching and promote sustainable urban agricultures

► **A collective construction :**

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1-Socio-scientific context : Global Ecological Transition

- World population mainly lives nowadays in megacities and that trend ↑. According to the Food and Agriculture Organization (FAO), **80 % of the world population will reside in urban areas in 2050.**

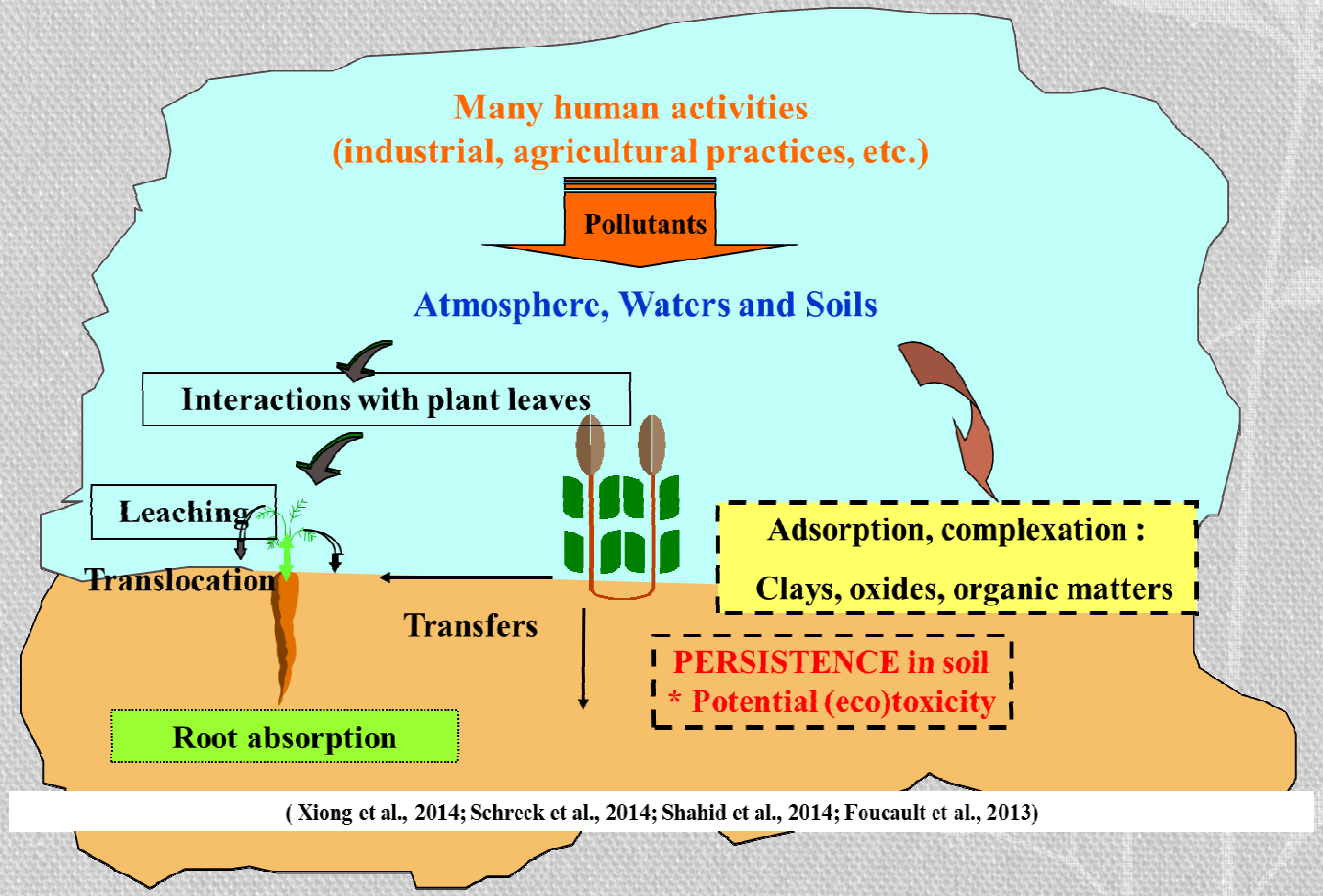
(New-york, 2015)

(Mexico, 2015)

(Ganghzou, 2015)

- Develop **sustainable urban agricultures** appears therefore crucial in order to protect urban soils and promote their ecosystem services : especially the production of large amounts of high-quality foods.

- But, **soil artificialisation continues** reducing arable lands (490 000 hectares lost between 2006 and 2014 in France). Moreover, current urban atmosphere and soil **pollutions** with (eco)toxicity consequences.



- **Complex ecosystems**: Soil-Plant-Atmosphere-Nutrients-Pollutants… Numerous interactions! **Pedagogically communicate** and develop **operational tools** that make sense in terms of **Society & Sciences**.

Goals…Ecological transition

Citizen engagement

Complex relationship Environnement & Health

Urban soils, atmosphere, and waters QUALITY

Food QUALITY

All citizens are concerned

Major challenge : developpement of sustainable urban agriculture.

Biodiversity

↓ Risks and ecological inequality.

2-Various actors concerned by urban soils (mayors, gardeners, researchers…) : different objectives

► Brownfields

« Cartoucherie » Toulouse : former military site transformed in neighborhood

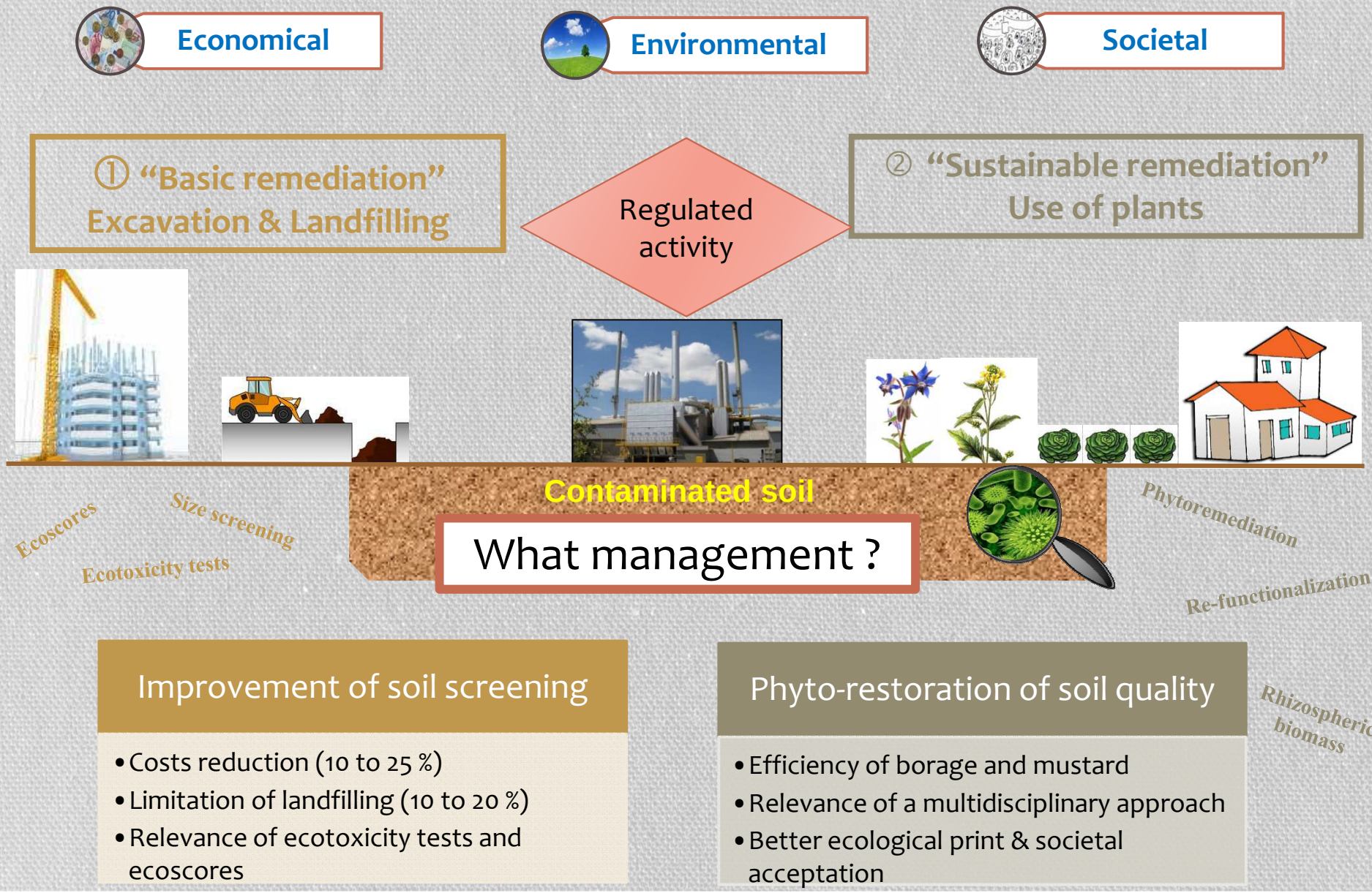
Brownfields management can permit both to reduce urban sprawl and solve the problem of scarcity of lands.

But, pollution and its financial and legal consequences is currently observed.

Alur law (2014) overcomes in France the **uncertainties and responsibilities** for the various actors (mayors, promoters…).
The obligations of information on polluted soils are strongly reinforced.

► **A lot of remediation projects for polluted soils of brownfields in the world…**

Foucault et al. (2014) : ecological rehabilitation and sustainable management of an urban industrial site with an historic pollution by metal(loid)s (Pb, Cd, Cu, Zn, As and Sb).



► Urban gardens : areas with several important health benefits !

For people > 60 years when they practice gardening activities :

↓ 30% health risk: cardiac or brain deseases

(Sweeden, 2013, 4000 persons).

Urban areas are crucial for sustainable food in towns.

But, gardenin such as other anthropogenic activities :
It's not possible to reach 0 risk !

What precautions for a healthy and sustainable gardening?

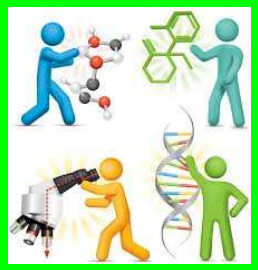
Think about :

- Nearby roads, factories ....
- Practices: use of Bordeaux mixture, pesticides, over-fertilization (NPK)
- Positive geochemical anomalies: As in Castanet-Tolosan ....
- What substance flows (inputs and outputs) in the ecosystem ?
- **Collective construction** of knowledge and of risk management

(Mombo et al., 2015; Pierart et al., 2015; Xiong et al., 2015; Dumat et al., 2015)

A socio-scientific reflection is needed for the sustainable management of urban soils and plants quality in order to reduce human exposure to pollutants. At various scales (region, country , world), several research questions are therefore asked :

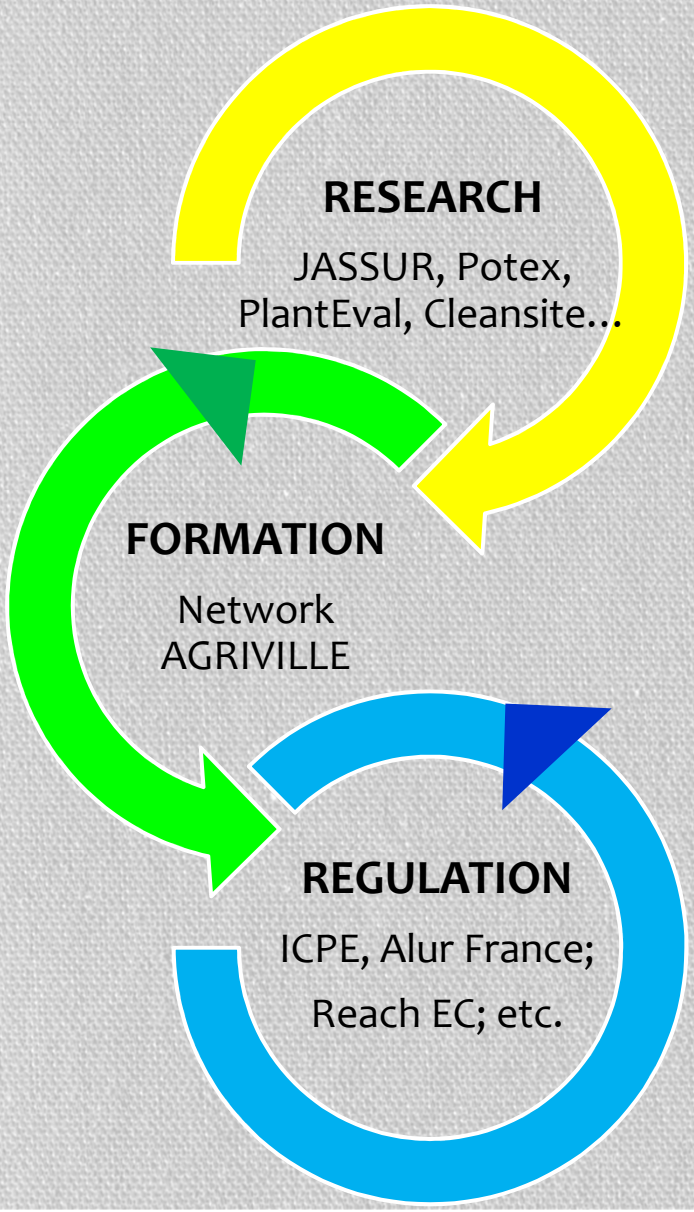
How to pool knowledge and successful experience feedback for the urban agricultures ?

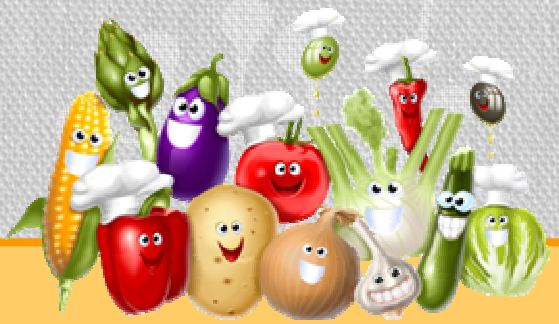


How to develop operational tools to classify soils according to typologies (for relevant roles) and regulations that enable sustainable management ?

The most populated urban areas often have pollution levels > background. What strategies to reconcile UA and pollution management ?

3-Several complementary socio-scientific projects are performed to favor sustainable urban agricultures





Collective Construction :

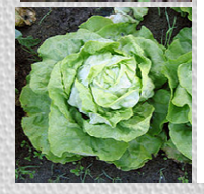
- **Knowledge**
- **Tools for management**
- **Regulation**

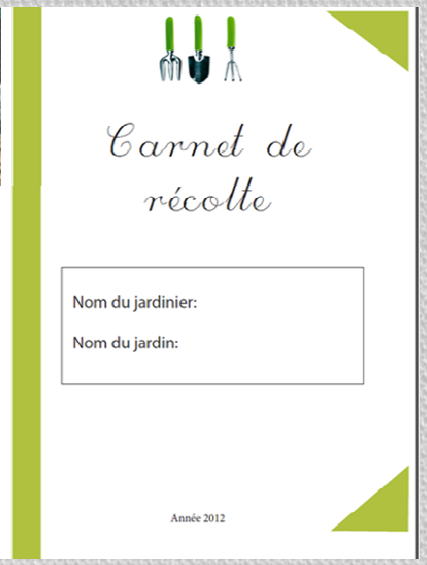
► Research projects

► National participative project « JASSUR » for sustainable cities

Measures and surveys with gardeners :
transfers and bioavailability of nutrients and pollutants,
quantities produced, media characteristics, practices.
Agroecological socio-scientific participatory and operational research

Bioaccessibility measures





Practices, risk perception, organization and management…

MAIRIE DE PARIS

Direction des Espaces Verts et de l'Environnement

► What management in the case of urban polluted soils?

- Soils are often « polluted » in towns (historical anthropogenic activities)
- Situation are complex to manage: (i) people generally want to continue their cultures; (ii) it's difficult to simply communicate on the subject.

Objectives of « POTEX » project on experimental gardens in Paris, 2013-2015 :

- Transfer of pollutants to the plants cultivated in urban areas (soil and air)
- Assess the pertinence of remediation techniques and the sanitary risks./ gardens.

Various contrasted polluted sites :

- Former gasworks (Parc de Choisy)
- Achères (urban sludges)
- site exposed to traffic pollution.

Various techniques were tested for cultures :

(i) replacing topsoil, (ii) use of a membrane, (iii) pot cultures

→ **Efficiency of management techniques** to reduce soil-plant transfers of pollutants.

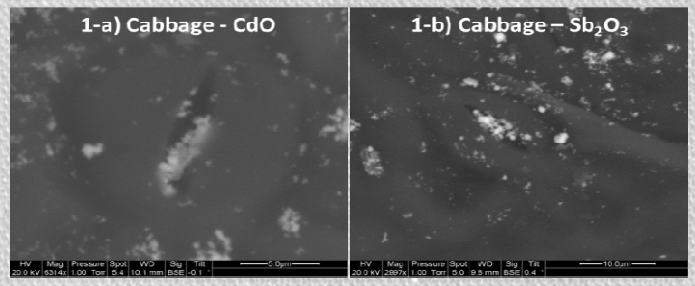
→ **Check the influence of atmosphere quality** especially on foliar vegetables.

● Quality of plants:
Influence of both soil and atmosphere quality

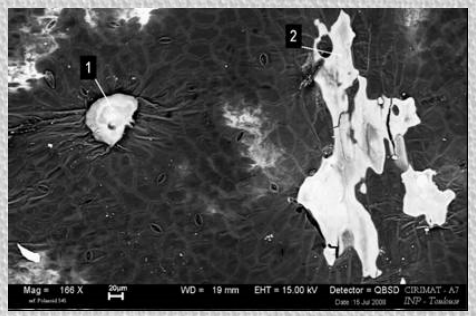
(Xiong et al., 2015 & 2014; Schreck et al., 2013; Uzu et al., 2011)

T. Xiong, phD

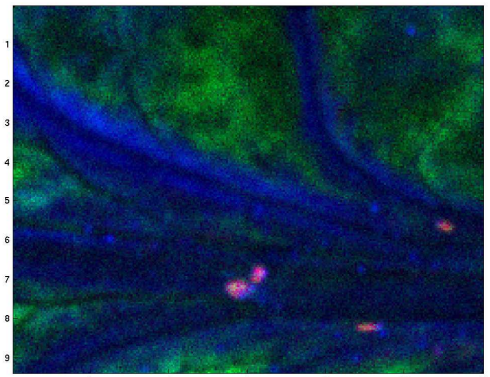
VARIOUS EXPOSURE CONDITIONS:
foliar or/and root transfers; nature of pollutants....



SEM-EDS observations of cabbage leaves exposed to CdO or Sb_2O_3 PM.



Pb in necrosis on lettuce leaves



µFluoX map : Pb localisation

- Careful washing of plants before eating.
- Bases of nerves for leave plants need to be deleted.

► Teaching projects

- Numerous scientific studies on soils illustrate the complexity and the profusion of interactions involved in ecosystems especially between pollutants, living organisms and soil organic matters (Dumat et al., 2006; Austruy et al., 2014…).

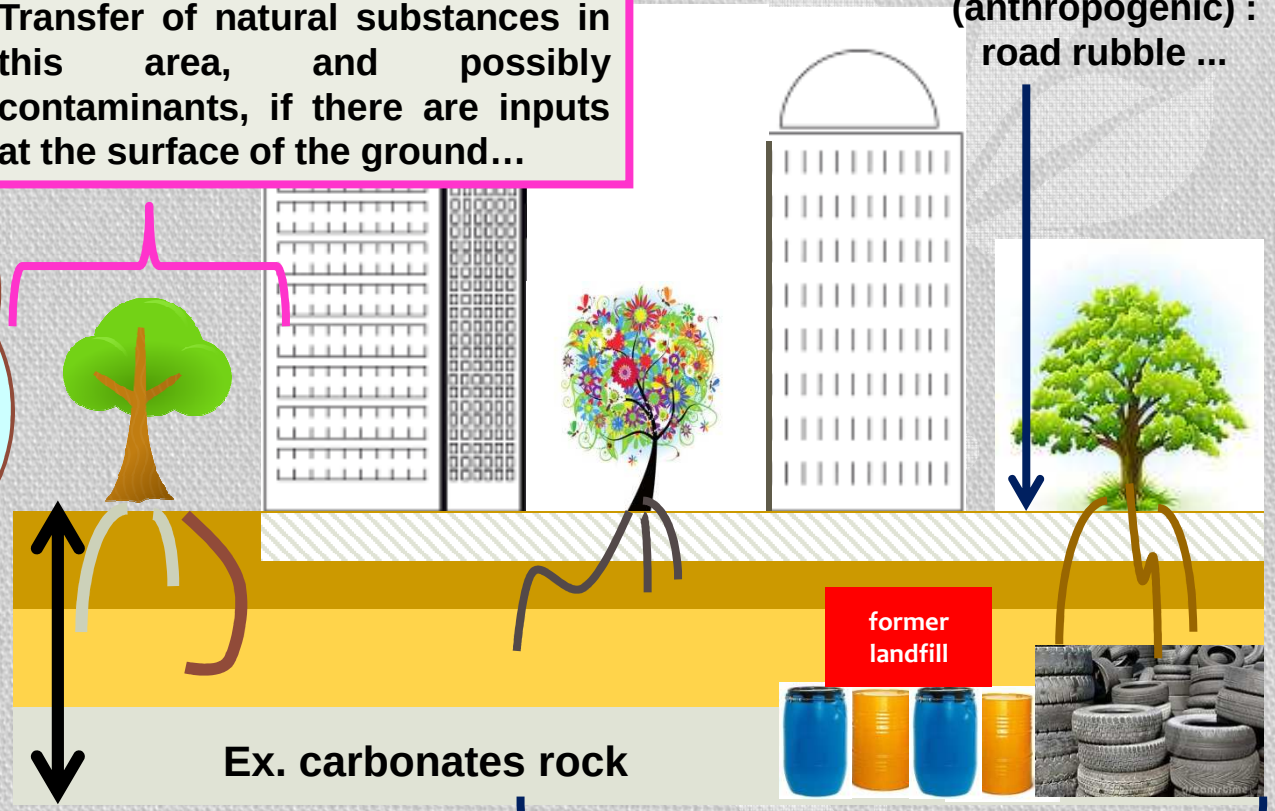
- How to reconcile scientific research thrust of the mechanisms involved in such complex systems and the emergence of practical solutions to improve the sustainable management of degraded soils and enhance ecosystem services? This is an important challenge for initiatives to bring science and society, such as innovation participatory "Network-Agriville" project shared and free resources :

http://reseau-agriville.com/

Transfer of natural substances in this area, and possibly contaminants, if there are inputs at the surface of the ground…

Artificial substrate (anthropogenic) : road rubble ...

The quality of soil and plants is influenced by the characteristics of the basement and also the irrigation water, atmosphere, fertilizers and soil ...



"Nothing is lost, nothing is created, everything is transformed" Lavoisier (1743-94).

Artificialized soil, altering its quality and reactivity (flow of water, biological life ...). Ensure the quality of the subsoil (cf. BASIAS, BASOL). Plant roots: from a few cm to several meters !

4-Conclusions and perspectives

- Useful scientific research projects are performed :
  - sources of data and innovation,
  - But not always operational ...
  - The environment-health relationship is complex !

Réseau AgriVille

- ***"Agriville network" was therefore created (2014) in order to promote preventive approach, pluridisciplinary and participatory Sciences & Society projects: researchers + citizens + students + professionals + politics.***

Sustainable practices - Ecological Transition.