



# Urban Agricultures (UA)

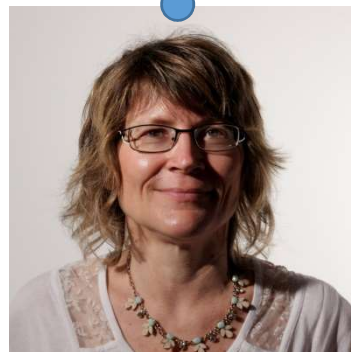


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Numerous socio-scientific research projects concerning UA are developed by  
« Réseau-Agriville »  
in collaboration with universities, gardeners, politics...



**Camille Dumat**  
PR INP-ENSAT  
**Environment-Health  
Society-Risks**

**CERTOP**  
**[camille.dumat@ensat.fr](mailto:camille.dumat@ensat.fr)**

► ***Publications :***  
<http://scholar.google.fr/citations?hl=fr&user=Klsn7dQAAAAJ>



**Dr Christine AUBRY**

Research ingenior, DR HDR  
christine.aubry@agroparistech.fr



**Dr Jeanne POURRIAS**

Ingenior, Doctor AgroParisTech  
jeanne.pourrias@agroparistech.fr

UMR SAD-APT INRA/AgroParisTech,  
AgroParisTech - 16, rue C. Bernard – 75231 PARIS Cedex 05





### **Syllabus :**

We want you to pass the following messages:

Different forms of UA are useful to feed people in the world.

The UA must reconcile several constraints :  
rational use of space, management of ecological inequalities and pollutions...

Technical innovations are developed :  
vertical farms, aquaponics, roof gardens ...

### **Summary :**

1-History, definitions and basic concepts.

2-Examples worldwide.

3-Advantages and limitations of UA.

4-Case-studies.

5-Conclusions and Prospects.

### **Keywords :**

Innovative agriculture. Ecological transition. Management of urban pollutions.



# What is your knowledge ?



## ► OBJECTIVES AND INTERACTIONS WITH OTHER SCIENTIFIC AREAS :

- Acquire the theoretical basics, vocabulary UA.
  - Find information about UA.
  - Implement development UA projects.

# Summary : Urban Agriculture (AU)



**1-Definitions,  
concepts.  
2-Examples in the  
world.**

**3-Advantages &  
limits.**

**4-Case studies.  
5-Conclusions &  
perspectives.**

# 1-History, definitions & concepts.

- 1-1. History of Urban Agriculture
- 1-2. Some data
- 1-3. The types of productions
- 1-4. The broad objectives
- 1-5. Definitions, concepts
- 1-6. Specificities of urbans agricultures

# 1-1. Story of urban agriculture

- One of the first traces of UA dates back to 4000 years, in semi-desert cities of Persia. A form of intensive agriculture was practiced there and used the waste of the community as compost.
- At Machu Picchu, the architecture of the city was designed so that water is retained and reused, the cropping systems collect heat from the sun, extending the growing season.
- Many "Victory garden" ("War gardens") appeared in the United States, Britain and Canada in the world wars. Community gardens were also very well developed in the late twentieth century. "Glenwood Green Acres" large and very dynamic community gardens in Philadelphia.





# The boom of urban agriculture

Sobocinski A. 24.02.2015. <https://lejournel.cnrs.fr>



- Cultivated roofs, shared gardens, wasteland exploited ... A green wave to new formats wins the heart of the cities of the Hexagon and Europe, having already conquered North America.
- In Île-de-France, the total area of associative gardens could reach that of the professional gardening area! There are a thousand small plots in Marseilles, where they grow vegetables on thirty hectares.
- Far from the conventional agricultural guns tucked into the smallest of gaps sometimes a few square meters, the phenomenon has intrigued scientists. What is behind this multiplication of experiments between concrete and asphalt? Fad or sustainable movement?

# Jassur, scientific project on UA

- To try to better understand the phenomenon, the Jassur program (urban associative Gardens and Sustainable Cities) funded by the National Research Agency, was launched in January 2013. **For UA, the definition varies across continents, is a more complex issue than it appears: "All the experiences of productive urban gardens do not meet the same dynamic. This can range from simple hobby to a real commercial activity through a project to restore the social link.**
- Another challenge for scientists: better understand the keys to the success of urban vegetable gardens. "They have developed at a rapid pace in recent years, from the time when concerns about climate change and the succession of different food scares - mad cow disease, dioxin chicken - have questioned **the forms of food production, their location,** " (Granchamp, 2015). Evidenced in particular the success of short circuits as the AMAP.
- Associations for the maintenance of peasant agriculture are producer groups who directly supply their members, customers fresh produce in the city. The return of farmers markets where producers gather in one place to sell their products directly, or AOC labels, which meet consumer

UA



Jardins Associatifs Urbains et villes durables : pratiques, fonctions et risques

# Urbans interested by nature in the towns

- The growth of productive gardens goes with that of the broadcasting of a real culture of sustainable development, awareness of environmental limits and the need for more sustainable practices (Consales, 2015).
- Interest of urban residents is no limited to a landscape and aesthetic nature, but also nourishing in relation with economic crisis. "These production areas in the city are changing eating habits in the direction of greater quality, including those from popular environments"



Family gardens of Castellon,  
Marseille XV<sup>e</sup> : 243 gardens.  
(Consales, 2015)

# UA, alternative food model?

- One of the main objectives of the research program Jassur is to quantify the productive value of urban gardens.
- The utopia of urban farming to large surfaces, faces to the land pressure (Glatron, 2015): conflict of use of space for the European cities. Moreover economic aspects need to be taken into account!



Lufa urban farm, build in 2010 on the roof of a building in Montreal.  
More than 25 plant species cultivated on 2 900 m<sup>2</sup>.



## 1-2. Few data

- 60% of humanity in urban areas in 2014 and forecast 2050: + 80% with 3 billion people on earth.
- FAO (Food and Agriculture Organization), responsible for fighting hunger in the world, considers the development of urban agriculture as a key food survival of humanity.
- 800 million people are involved in the AU and contribute to feeding urban residents.
- Low-income urban dwellers spend between 40% and 60% of their income on food.
- By 2015, 26 cities exceed 10 million. To feed a city of this size, at least 6,000 tons of food must be imported each day !

# 1-3. Ways of production

- Gardening
- Small livestock (poultry, pigeons, rabbits mainly), particularly common in some developing countries or regions of China, held back during the expansion of the H5N1 virus appears to have been transported mainly by trade in poultry and markets live poultry.
- Fruit trees (eg. Apple orchard in the heart of Eva-Lanxmeer eco-district the Netherlands, meeting the annual needs of inhabitants in apples and apple juice) or may have some symbolic value.
- Cereal production (in Wittenheim Mittelfeld).

- Some sheep, cattle, goats hardy breeds in maintenance of urban grassed areas: ponies and a bull Highland cattle shearers to the citadel of Lille (Historical Monument), including on steep slopes inaccessible to lawnmowers.
- In addition, the movement of livestock from one site to the other animals gives a role of biological corridor.



# 1-4. The main objectives

- Economic and direct food possibly survival in the poorest countries; that agriculture is a means of solving problems with the management of certain municipal waste (biodegradable or likely to feed animals);
- Furthermore, a direct sales attractive to the farmer and the urban, social or educational functions are measured in so-called developed countries. Thus, there are educational farms or doing work for the disabled; the production target is there but is secondary. Some urban parks (eg. In France, Parc de la Deûle south of the urban community of Lille) integrate local agriculture, with the idea of green belt, country park or city break.



- Urban and peri-urban agricultures are one of the solutions recommended by FAO to address food security needs.
- According to FAO, the UA is already used by some 700 million urban dwellers (1/4 people in the world), and if the trend continues, by 2030, almost all of the growth the population will be in cities in emerging countries and about 60% of the inhabitants of these countries will be urban.
- Some eco-neighborhoods have integrated an urban farm in their scope (EVA Lanxmeer, 250 homes and offices in the Netherlands). Often the eco-neighborhood seeks to establish an AMAP type of device nearby.
- Architects, urban planners and futurists have dreamed of as vertical farming projects.

# 1-5. Definitions and basic concepts

**The city defined differently  
in function of the countries and perspectives**



Concept apprehended from statistical data, analytical (specificities of the urban environment), or based on the use of space (built space vs open space)

**"A vague concept"** (Snrech, 1997)

► **Urban Pole**

Compact agglomeration cash 5,000 jobs or more.

An urban area consists of an urban center and through joint which at least 40% of the resident population in employment working in the pole.

► **Peri Crown of an urban center**

All peripheral municipalities of the urban area to the exclusion of its urban center.

► **Multi-polarized Commons**

Municipalities (small towns) located outside urban area of which 40% or more of active residents will work in several urban areas, without reaching that threshold with one of them.

The predominantly urban space consists of all urban areas and multi-polarized towns.

► **Predominantly rural areas:** the rest.

*UA: Localized agriculture in the city or its outskirts, whose products are mainly for the city and for which there is an alternative between agricultural and non-agricultural use of resources (land, water, labor...).*

*The alternative of open competition and use complementarities (Mbaye & Moustier, 1999) ≈ ditto van Veenhuizen, 2006*

Field



Vacant land in urban areas



On the frame (bâti)



**A diverse agriculture Urban**



Many forms of "peri" urban agriculture  
The first studied in the northern countries  
(landscaped role on life quality ..),  
and more recently food and economic interest (short circuits)  
The location is important (pressures on soil resources)  
but also the functions: intra-urban and peri-urban



Market, picking, AMAP, farm shop ...

UA "refers to small areas (vacant lots, gardens, orchards, balconies, various containers ...) in town to cultivate some plants and raising animals for household consumption or sales of proximity" (FAO , 1999)

**UA is an industry located within (intra-urban) or in the fringe (peri-urban) of a town, a city or a metropolis, which grows and raises, processes and distributes a diversity of food and non-food products, (re)-using largely human and material resources, products and services found in and around that urban area and in turn supplying human and material resources, products and services largely to that urban area (Mougeot, 2000)**

"Growing plants and raising animals for food and other uses in and around cities of varying sizes, and related activities such as production and input supply, processing and sale of products. UA is in or on the fringes of the city and includes a wide variety of production systems, from those self-subsistence to the household level up system fully dedicated to the commercialization "(Van Veenhuizen , 2006).

A very variable recognition by public policies:

- the delegitimization (Cissé et al, 2002)
- prior to the current layout (Food councils, agri-urban projects ...)

### ***Lobbying networks***

*(RUAF created in 1999, Terres en Ville in 2001, PURPLE, Periurban Regions Platform Europe: 1st AG in 2005)*

### ***Growing research networks***

*IDRC (Canada) and its Agropolis program, regional programs (SUSPER Vietnam, Madagascar Aduraa, DAUME Montpellier)*

### ***New exchange networks for Cities Food (FAO) since 2009***

*Seminars, conferences etc. 2013: Urban Agriculture in time of economic crisis (ESRS Workshop at the 25th Conference)...*

## Both scientific and politic « Concept »

### Scientific

The combination of social, environmental and economic (multifactorial SD) (Lawrence, 2002; Mundler, 2010) near "ecosystem services" within the meaning of the MEA?

"Ecosystem services" (MEA): supply, regulation, support, cultural

### Politic

OMC, 1999, Group of Cairns

OMC (1999): "Concept that agriculture has many functions in addition to producing food and fiber, eg environmental protection, landscape preservation, rural employment, etc .."

« Task Force of Multi-fonctionnality »  
of the Dutch Ministry of Agriculture.

## Diversity of functions and questions in the search:

UA is generally **Multifunctional**

Fleury, 2005 ; Wiserke, 2009; Zasada, 2011

**Food service**, including fresh produces (fruits, vegetables, eggs ..).

**Economic and social function** : direct and indirect employment?

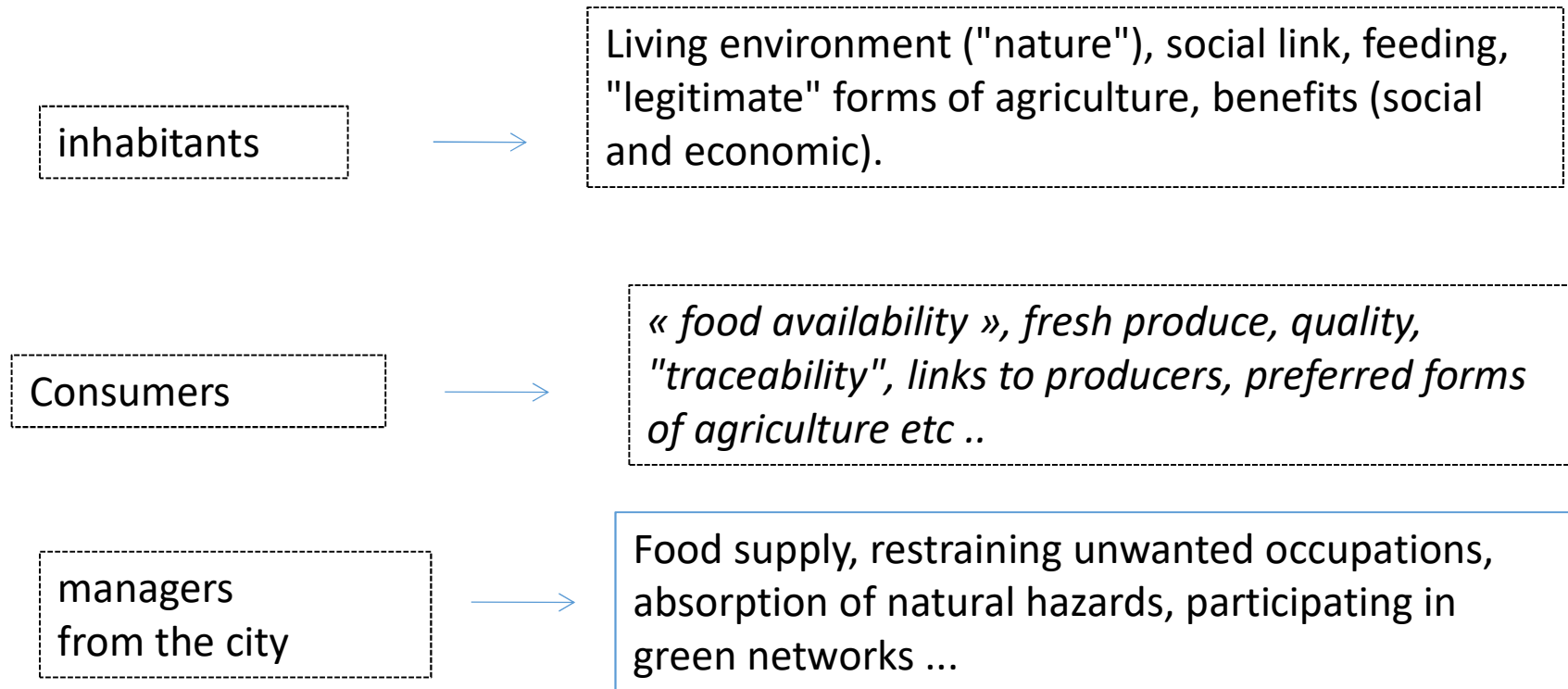
**Environmental function** : Protection against natural hazards (floods), upgrading of urban waste, biodiversity town.

**Landscape function, living environment**: Important to consider for new projects.

**Educational and recreational function** (gathering, educational farms, associative gardens).

A working hypothesis :

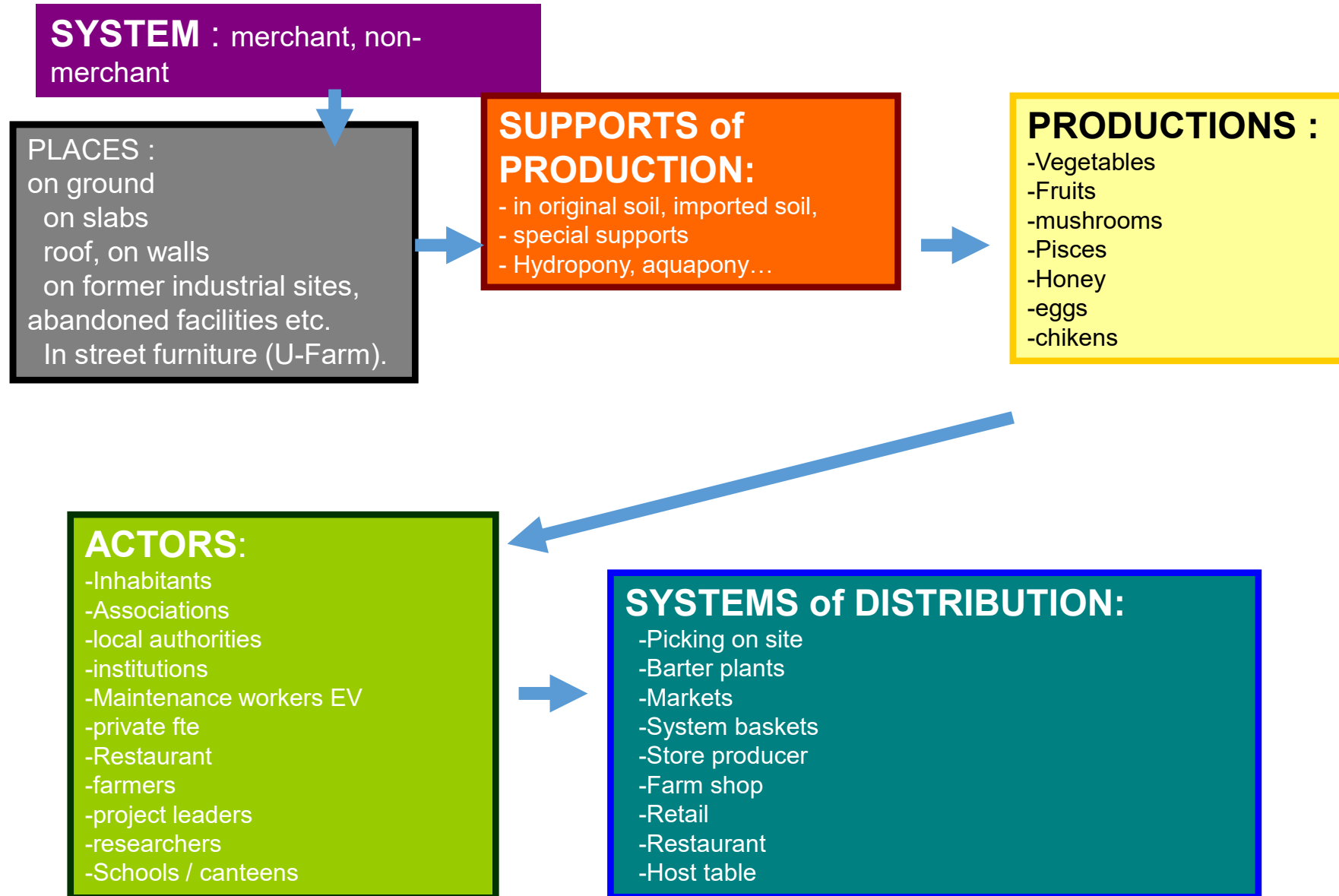
the AU can maintain or develop only if its functions (variables between forms and in different contexts) are recognized by urban.



*"The city" can strongly guide the systems of production and marketing and also the production techniques.*

*various hierarchies,  
and possibly contradictory functions-services  
depending on the players*

## Diversity of UA Forms "in town"





## Quantify, qualify, prioritize functions UA-services

In the "urban metabolism" (Barles, 2002)  
in the "DD cities" (Emelianoff, 2007)

Hypothesis

In situ maintenance of UA only if  
"Double Sustainability"

(Godard et Hubert, 2002)

(Aubry et al, 2008,2012)

**Internal Durability (ID)**

**External Durability (ED)**

Is UA economically viable, socially bearable  
and uses resources sustainably?

*The "urban" recognize him-service functions that can  
not (or hardly) be filled by other uses of space  
(contributes to economic sustainability, social  
sustainability and sustainable management of  
resources of the city)*

If only ID, UA is condemned to disappear,  
if only ED, AU lives under the city infusion  
Understanding the elements of dialectics:  
urban extension / dynamization

## Food function

Quantitative contribution to urban supply

*Depending on the product, statistical data or produce*

Contribution to the supply of categories of population

Consum'actors, locavores, poor families (including autoproduction)  
school meals

From quantitative to qualitative: Nutritional functions

"Fruits and Vegetables"; Food availability; Re-discovery of vegetable consumption in North America (Urban Community Gardens) (Litt et al, 2011)

Quantitative contribution (based on production levels) and / or qualitative urban agriculture to food supply of cities, globally and / or in relation to certain categories of people.

1/4 to 1/3 of food production from the Southern Mediterranean cities  
produced by the UA in 2003 (Padilla, 2004)  
1/5 to 1/7 in 1990 (UNDP)

From 60 to 100% FRESH PRODUCTS (vegetables, fruits, eggs ..) provided by UA  
and suburban gardening.

### A Antananarivo, Madagascar

UA produces

**90 % of watercress  
consumed**

85% of tomatoes, 100% of cauliflower

**12 à 18% of consumed rice.**



Dakar , Ba 2007



Kenya (Ruaf)



↑ urban food security /  
resiliency (RUAf, 2010)

Domestic food production by poor urban households  
represents 10-60% of their total consumption:

- Jakarta East: 18% (2000)
- Kampala 40-60% (2007)
- Harare 60% (2000)

- The urban producers are more resistant to increases in  
food prices (FAO, 2008).

## environmental functions

Prevention of natural hazards (floods) and / or food security / risk (Japan)

Participation in the urban waste disposal

Participation to biodiversity dynamic

Reduction of C, GES, energy

Reducing urban heat islands, thermal regulation

Prevention of natural hazards and urban waste in the South

Exemple Biodiversité au Nord

# Preventing natural risks

*Antananarivo : rainy season floods*



Rice fields and watercress can store water: a valley of 287 ha stores 850,000 m<sup>3</sup> of water is 3 consecutive days of very heavy rain!

**UA = “The cheapest and most effective way to fight against floods” (BDA, 2005)  
(inclusion in the plans of facilities)**

**Recycling of  
municipal waste**



Were tested in market garden systems, the agricultural interest of the “loam (terreau)” of Andralanitra: efficient such as the chemical fertilization (N'Diénor, 2006)

**A growing theme**

Urban Waste Recycling : numerous experiments (RUAF magazine juillet 2011 [www.ruaf.org](http://www.ruaf.org) )

Projet ANR ISARD 2008-2012 (Sénégal, Madagascar, Réunion, Plaine de Versailles)....



## Gardeners in short circuits: Ile de France (and elsewhere ..)

Very high diversity of the **PRODUCTIONS**

**50 to 130 of different cultures différentes** on 10 ha only ! (Pourias, 2010) *With a lot « old cultivars » of plants cultivated.*



The **biodiversity is cultivated** :  
a dual-role advantage: contributing to global biodiversity and changing practices.

*Strong tendency to LIMITE cultural operations.  
Few chemicals, mainly use of organic fertilizers ..*

*No products  
available*

*No time for the inputs  
"IMPASSE" and manually  
correction.*

*« Culture diversity is a  
protection »*

**"Urban" market gardeners who call themselves  
closer to the "BIO " practices (organic matters uses...)**

# 1-6. Specificities of urban agricultures

- Generally **little surfaces** to develop UA
- It's crucial **to check and manage quality** of soil, atmosphere, waters and improve these media with **sustainable practices**.
- **Biological agriculture** permit to decrease sanitary risks and to use organic wastes (compost, anaerobic digestion of organic compounds...).
- The **information and collective construction** of the UA projects are crucial steps.
- Urban agricultural projects are **multidisciplinary** and they fall under the city policy and the public space dynamic. These UA projects carry several different services.



## However

- The methods currently implemented in agriculture are of course to mobilize, although UA.
- Cultivation in hydroponics is most often used (new vertical farms, low availability of soil surfaces).
- Technological and architectural feats are developed to address the lack of space and optimize energy flows , material ... with a view of sustainable city.
- Knowledge on soil-plant-atmosphere transfers of chemical substances is needed.
- Regulation is crucial : ICPE (reduction of risks induced by anthropogenic activities, reduction of industrial emissions...), REACH, etc...

## 2-Few examples of UA in the world.

- 2-1. Europe and North America
- 2-2. Taiwan
- 2-3. World's Largest Indoor Farm in Japan

## 2.1-UA IN EUROPE & NORTH AMERICA



*Gardens near buildings  
(Colombes) ACD*



*Garden, AMAP and  
educational farm in a park—  
Ivry —photo ACD*



*Urban farm in NYC (Queens County Farm)  
photo JP*



*R-Urban project of the  
Architecture Studio .. Autog*

- Depending on the availability of urban land (the availability, price)
- If risks of urban land pollution, soil reported (traceability ground?)
- Multiple roles (avoid antisocial use, sell, create links etc ..)
- Pest problem / no incentive to deal
- Problem of human pests ...





**Prinssezinngarten,  
Berlin**  
(Associative gardens and  
restaurant -photo ACD)



**U-FARM.** Oyster mushrooms  
on Marc Café in containers  
(Photo ACD)



**Randall Island urban Park NYC**  
(photo JCP)



**Thorthon's Budgens  
London**



**Brooklyn Grange NYC**  
4000 m<sup>2</sup> Rooflite + mushroom  
compost.



**Educational garden.**  
Univ Mc Gill – Montréal  
(photo JP)



**INRA / Gardens on roofs** AgroParisTech, use of  
local materials. Photo NB

# In France

- Since 2000 a Network encourages cities in land agricultural policies of cities and works for the protection and development of peri-urban agricultural and natural areas, including through the PAEN (Périmètre de protection et de mise en valeur des espaces agricoles et naturels périurbains) = perimeter of protection and development of agricultural and natural peri-urban areas).
- Marais de Bourges, classified since 2003 "Natural Monuments" form of urban farming enclave of 135 ha. The "Mittelfeld" in Wittenheim: UA area of 90 hectares located in the suburbs of Mulhouse, her vocation was confirmed June 25, 2010. One hundred community gardens were created in Paris. They facilitate relationships between people, encourage meetings between generations.
- The Ful (Lyon Urban Farm) to be launched in 2016: superposition of technical platforms for production of hydroponic lettuce.



# At the International level

- A traveling exhibition "Carrot City" went around the world since 2009. It showcases the innovative projects of the cities for UA. It highlights the relationships that can be made between food systems and urban architectural forms with the aim to make cities more sustainable. It was exhibited in New York, Montreal, Berlin, Rabat, Paris ...
- In 2011 is created the first international network on food governance of cities: "IUFN, International Urban Food Network". It aims to strengthen cooperation between local authorities and the scientific community around the food issue. This network brings together members of industrialized countries and the BRIC (Brazil, Russia, India and China).

## Plants and eat the city, the incredible revolution

- As part of their program for "(revolutionize agriculture", the hummingbirds have joined forces to Incredible Edible, a citizen movement born in Britain that has spread around the world, with a simple yet powerful principle: plant vegetables everywhere, take care collectively, and allow anyone to use in crops, for free.
- The Incredibles Edibles are citizens micro-movements, born of each initiative. If it does not already exist in your area, it's up to you to create it !



# How Urban Agriculture Builds Food Security in Rainier Valley, Seattle

- One 4x8 foot raised bed allows a family to grow up to \$200 worth of food each growing season.
- Started in 2010, the Just Garden Project, a program run by Seattle Tilth, has built more than 100 gardens for low-income households throughout King County – providing nutritious food for more than 2,000 people.
- The Just Garden Project subsidizes the construction of gardens for low-income residents at the cost of \$25 for one raised garden bed, which includes construction, seeds, a growing guide, and free gardening classes – a small price to pay for a tool that will allow families to sustainably feed themselves over a long period of time.



# Educational Farm 'la ferme des 50' » Ramonville, 31

- Association created in 1986 in Ramonville Saint Agne. to promote environmental education for all: (i) educational farm with farm animals (farmyard, pigs, goats, sheep, donkeys, horses, rabbits, llamas), an arboretum, and a pond vegetable ..; (ii) family gardens that are available to people of Ramonville, wanting to be in a friendly place. Etc ...



## **Vertical vineyard culture :** **grapes accessible from the windows, Lille, Northern France**



C. Dumat

## Why cultivate not only in the original soil ?



*Several techniques coming from south countries.*



Le Caire



Dakar



Photos  
CA

- No place on the ground (frame)
- Too costly destruction
- Polluted soil
- Physiological needs (mushrooms)

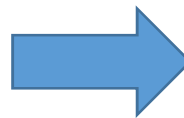
Very different substrats

Exogenous or local

Agronomic qualities?

Regularity?

Possible pollution?



***Culture substrate  
engineering***



## Agriculture forms of hydroponics in town

### Lufa Farm (Montréal)



Gotham Greens,  
New-York

### The project of the Cultural Tour of market garden plant of Romainville



**FarmedHere, Chicago** Production with  
aquaponie of lettuces (8300 m<sup>2</sup>)



Vertical farm project ,  
Chicago

- strong investment
- High productivity ( $> 20 \text{ kg} / \text{m}^2$ )
- Landscape integration?
- Energy balance?
- Social inclusion?

## **La ferme urbaine de demain : à la verticale au cœur des villes ?**

Architects, designers, agronomist engineers combine their skills (Le Monde, 2014).

Even anticipating certain technological developments, traditional agriculture can not meet the demand for food: 80% of the arable areas of the globe are already in operation, and 15% of these soils have been depleted (intensive agriculture, pollution, desertification ...).



## Possible advantages of vertical farms :

- ☐ Improved yields by protecting crops from bad weather;
- ☐ Creation of new fields without negative impact on the environment and disinvestment areas currently assigned to agriculture.
- ☐ Reduction of channels of distribution and storage, consuming fossil fuels;
- ☐ Reducing the use of insecticides, herbicides ...
- ☐ Systematic Recycling of waste water;
- ☐ Creation of drinking water through evapotranspiration recovery plant;
- ☐ Improved air quality (CO<sub>2</sub> plants store and produce O<sub>2</sub>);
- ☐ Reduction of greenhouse gas emissions;
- ☐ Valorization of organic waste (composting, anaerobic digestion);
- ☐ Energy Self-sufficient through solar or wind sensors installed on the structure ...

## Soon a concrete implementation?

- ❖ The Construction costs (a project currently under consideration in Las Vegas is estimated at \$ 200 million) and they will operate offer the products at a competitive price? (actually with several examples...it's no).
- ❖ Only the implementation of a first vertical farm layout will provide answers within a few years, if one of the projects currently under consideration was born in Vancouver, London and Abu Dhabi ...
- ❖ The Many architects and designers have sometimes surprising aesthetic interpretations, but most agree on: **a tower of 30-40 floors (for 150-250 meters high), in which coexist crops and livestock; energy autonomy, systematic recycling of wastewater to reduce the environmental footprint of these buildings outside the norm.**

## A lit

- ❖ Philips has a vertical farm, home
- ❖ Its five levels grow plants and 2nd level provides oxygen for vegetables
- ❖ A System of organic water even (in p



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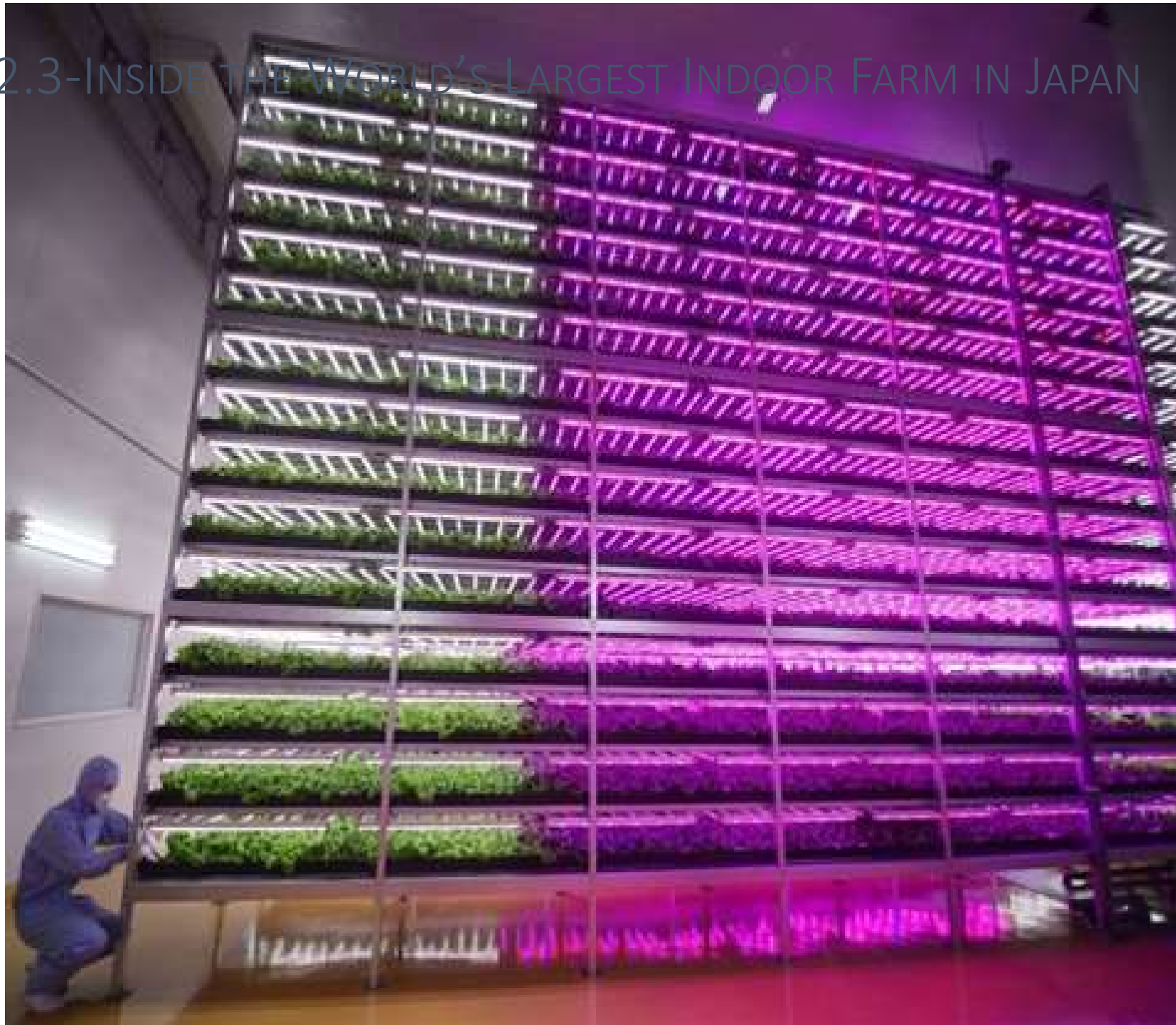
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set and

## 2.2-The city of New Taipei encourages UA

- ❖ A New Taipei, the most populated municipality of Taiwan with 3.9 million inhabitants and whose territory encircles the capital Taipei, residents are invited to convert roofs and vegetable gardens in vacant spaces - bio.
- ❖ The municipality of New Taipei covers rural areas, peri-urban and highly urbanized neighborhoods where residents can, through the UA improve their living environment and promote organic farming (Liao Jung-ching in charge of Agriculture within the municipality). Xindian District, hillside neighborhood where residents grow for many years the gardens.



## 2.3-INSIDE THE WORLD'S LARGEST INDOOR FARM IN JAPAN





## 3-Advantages & limits of UA.

- 3.1-Direct or indirect economic benefits
- 3.2-Environmental Benefits
- 3.3 Social-Benefits
- 3.4 Limitations, difficulties; Potential risks (pollution).

### 3-1) Direct or indirect economic benefits

- Creation of internal trade in the communities.
- Diversified economy for the people in need.
- Reduction of solid waste recovery costs (less of packaging related to transport).

## 3-2) environmental benefits

- ☐ Reducing air pollution (air cleaning).
- ☐ Reducing carbon emissions (less transportation).
- ☐ Reuse of gray water (less runoff).
- ☐ Solid waste reduction (fewer transport-related packaging).
- ☐ Improving soil quality.
- ☐ Reuse of vacant lots.
- ☐ Public awareness of the environment.
- ☐ Reduction of transport, packaging for marketing.

## 3-3) Social benefits

- Leisure.
- Food security (food more accessible).
- Accessibility of food and reducing their costs.
- Formation of a sustainable society.
- Training, education, belonging to a group, a project.
- Dietary diversity (fresh food and good quality).  
Cohesion and well-being of the community.

# Funding

- Helpers communities, solidarity banks, or type.
- Third investor exist or are theoretically possible (including through such systems shared gardens, allotment gardens, home gardens, etc.).
- Sometimes it's a group of motivated citizens that seeks to establish an area of UA and suburban to meet its needs.

## 3-4) Limits & difficulties

- Cost of land;
- Pressure of urbanization and peri-urbanization;
- Pollution that often affect urban and suburban soils;
- Access to water (often already rationed in arid areas);
- Health risks induced by the use of sewage sludge or urine and feces poorly composted or unsafe from a health point of view; risks related to semi-industrial farms (eg avian flu or other zoonotic diseases, poor waste management, etc.).

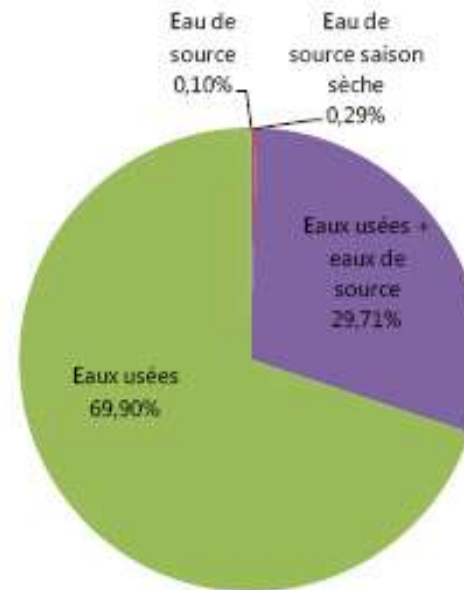
## **Potential risks**

- ▶ **Pollutions currently observed in urban areas...**





## Direct discharges of factories



Function "purifying"

### Upstream (amont)

Bacterial fecal pollution and COD  
/ BOD 2.7 (> 0.5)

### Downstream :

Reduction organic matters,  
nitrates, bacteria...

But a contaminated product :  
more than 4,000 colonies of E. Coli / g  
(OMS standard <100)

## A permanent question : Urban pollution risks on productions in town?

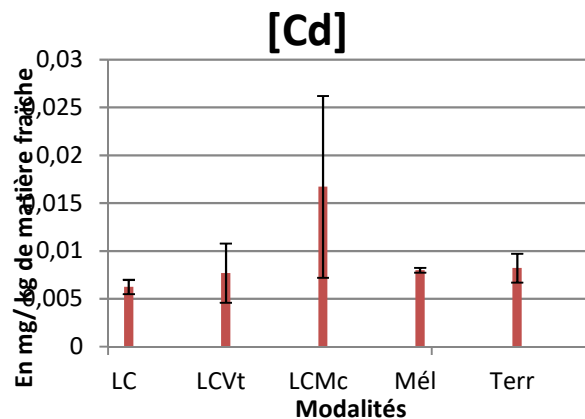
\* Risk of polluted soil or polluting atmospheric deposition.

Proven risks in certain situations (Berlin)  
(Samuel, 2012)

ANR JASSUR (2013-2016) compared to food production and pollution risks (soil, crops) in 7 cities of France.

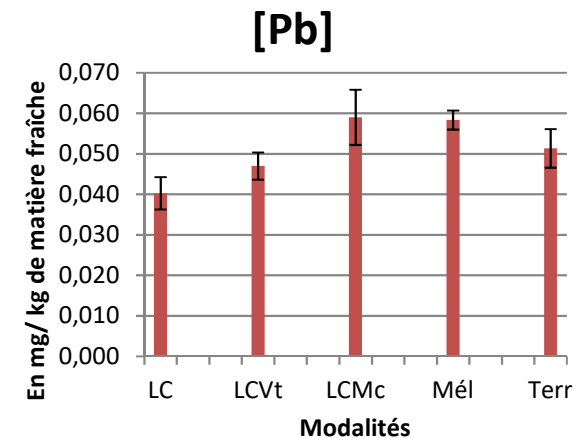
Intra -Urbain is not always the fear that polluting ..

Metals concentrations in lettuces cultivated on the roofs of AgroParistech 2012 (Garin, 2012 ; Aubry et Bel, 2013)



**EU limits :**  
Cd: 0.3 mg/kg of fresh weight (FW).

Pb: 0.2 mg/kg FW.

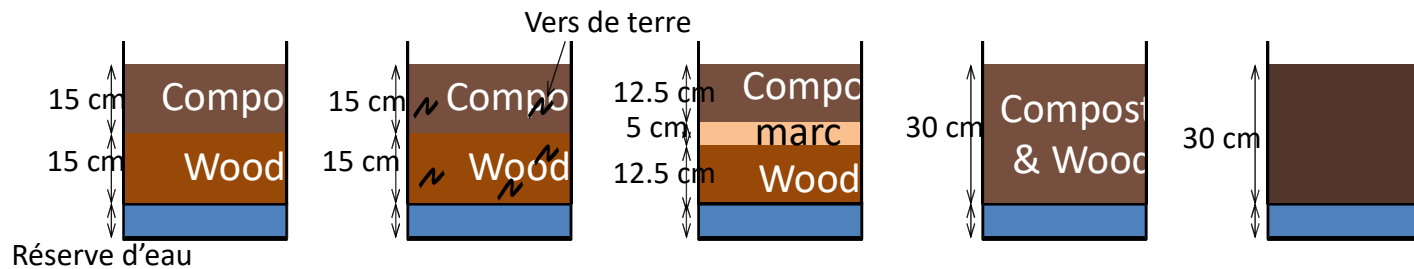


## Collective gardens in Paris (Pourias, Daniel, 2013)

### Contribution to the biodiversity

*Urban gardening 50-130 different species in less than 10 ha  
(Pourias, Lamarque, 2010)*

### Valorization of urban wastes



### Project T4P Productive roofs in Paris

Other possible urban wastes

- Waste Market
- Organic household waste to be composted
- Organic waste from canteens
- Etc ..

Other environmental functions

Reducing urban heat islands?  
Contribution to the capture of rain?





Parc de Choisy 13<sup>e</sup>

Volatil polluants



Rue Bruneseau 13<sup>e</sup>

Atmosphere polluants

4 sites



Achères 78

Metals



Terrasse 7<sup>e</sup> du 103 av France 13<sup>e</sup>

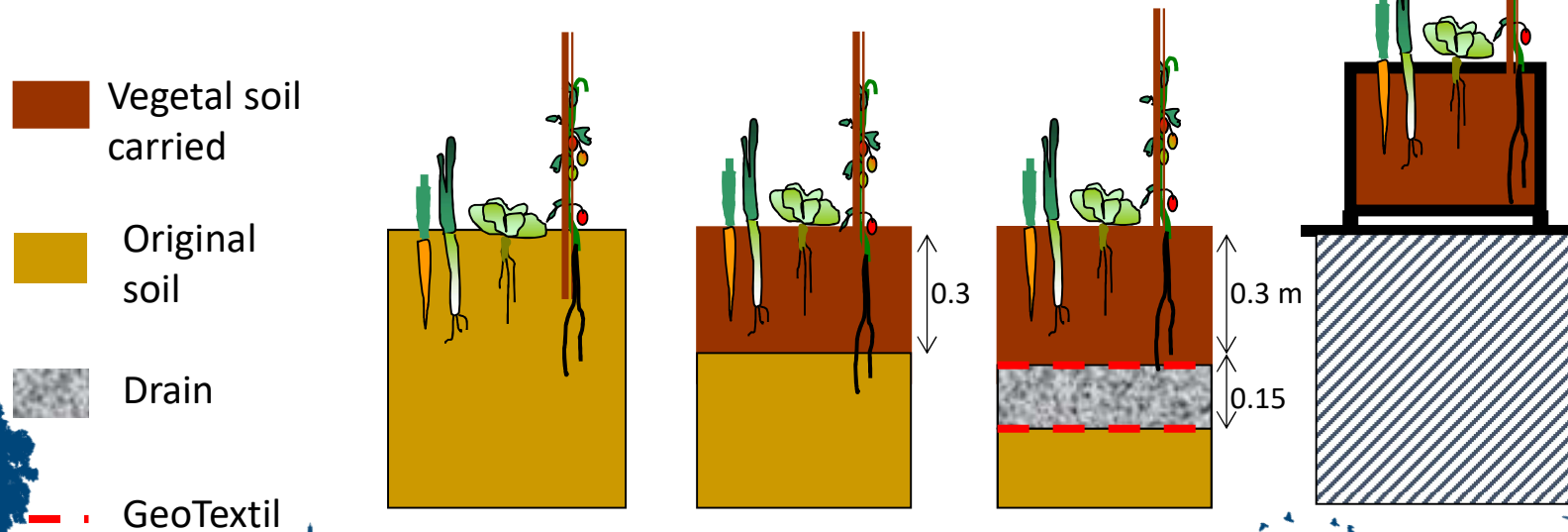
Atmosphere polluants



## Conditions tested to reduce pollutants transfers towards plants...

➡ 9 parcels (each 10 m<sup>2</sup>)

	Original soil	Vegetal soil carried	Vegetal soil carried on drain	Bac above ground
Choisy	C1	C2	C3	C0
Achères	A1	A2	A3	
Bruneseau				B0
103 terrasse				F0

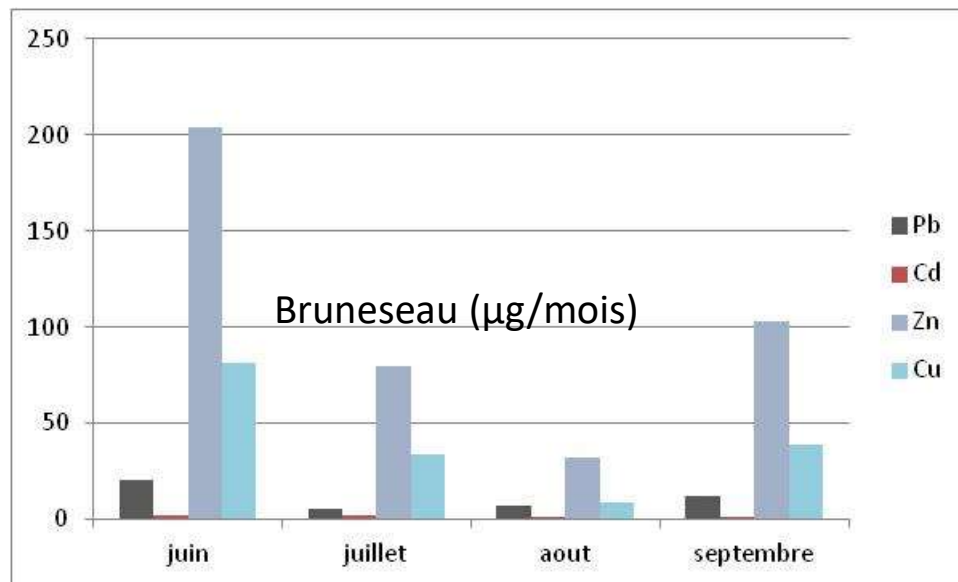






## Atmosphere fallouts

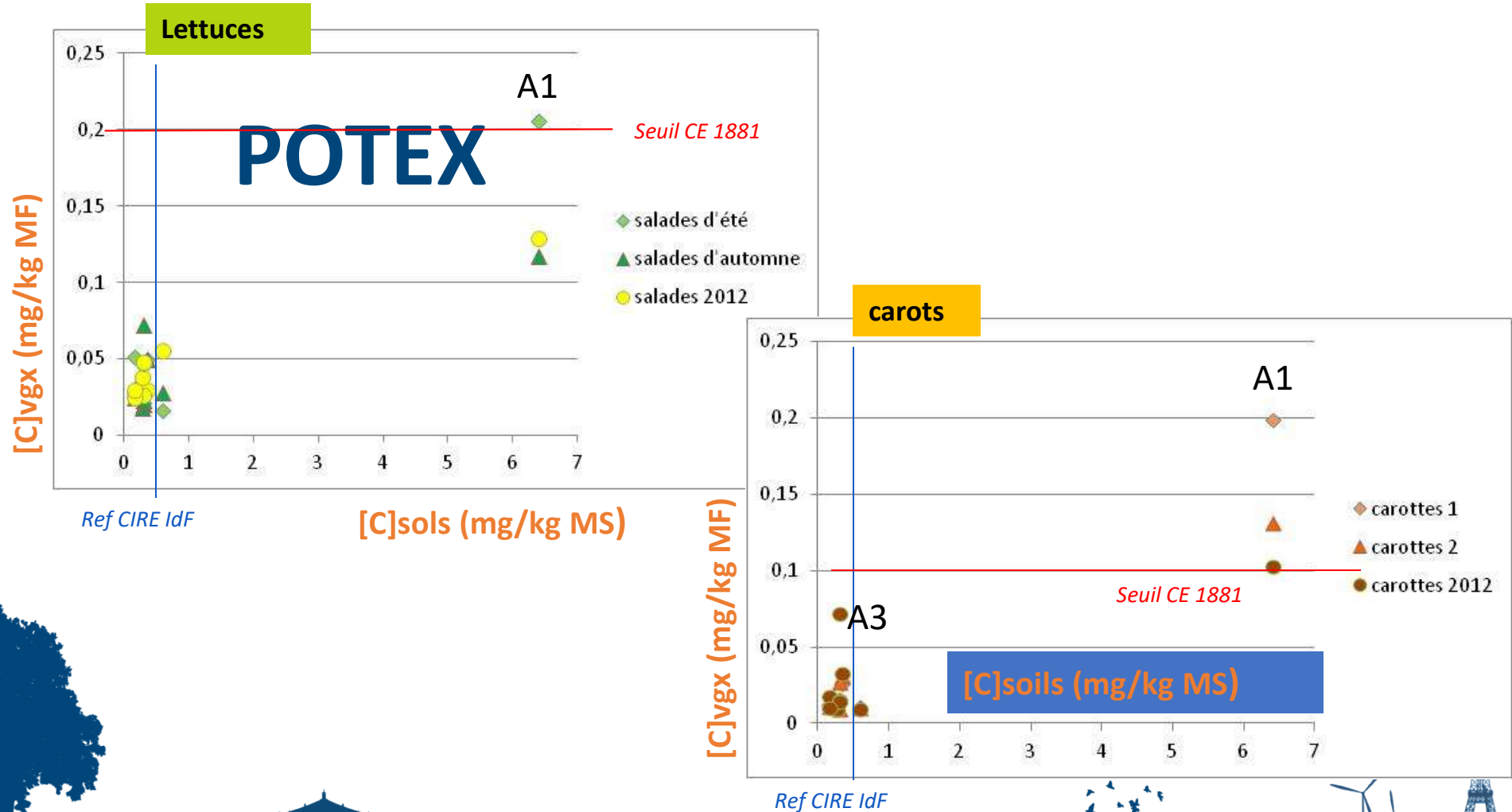
➡ POTEX





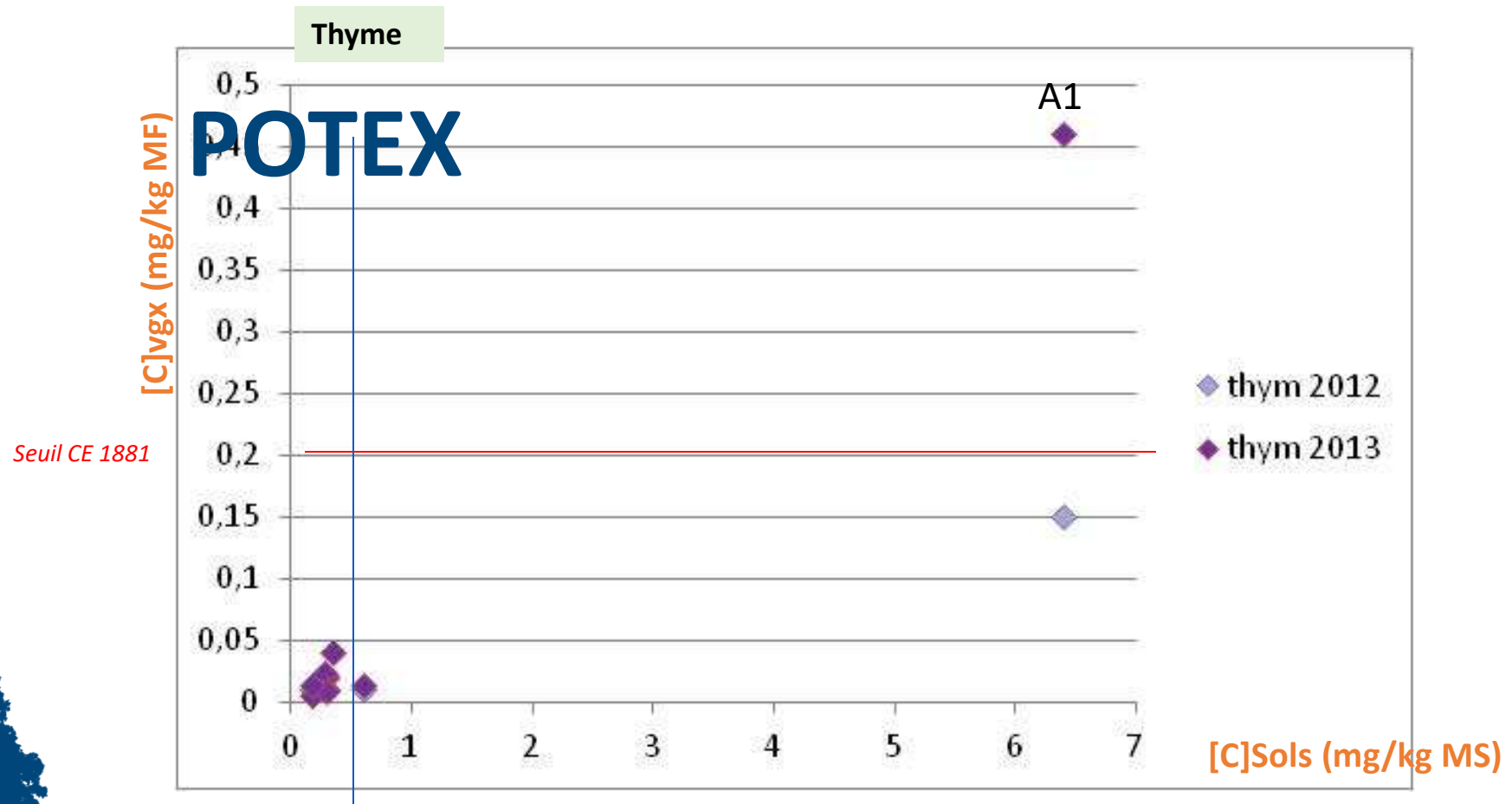


## Cadmium: concentrations in soils and vegetables...





## Cadmium: soils and plants



Ref CIRE IdF

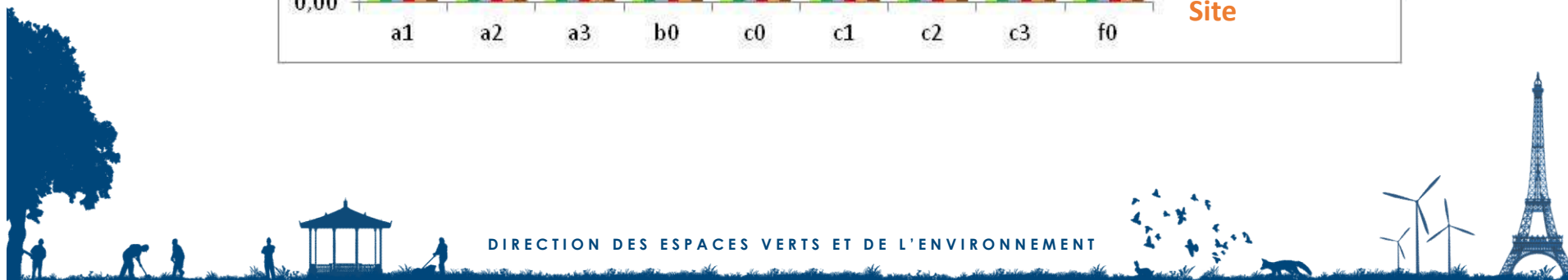
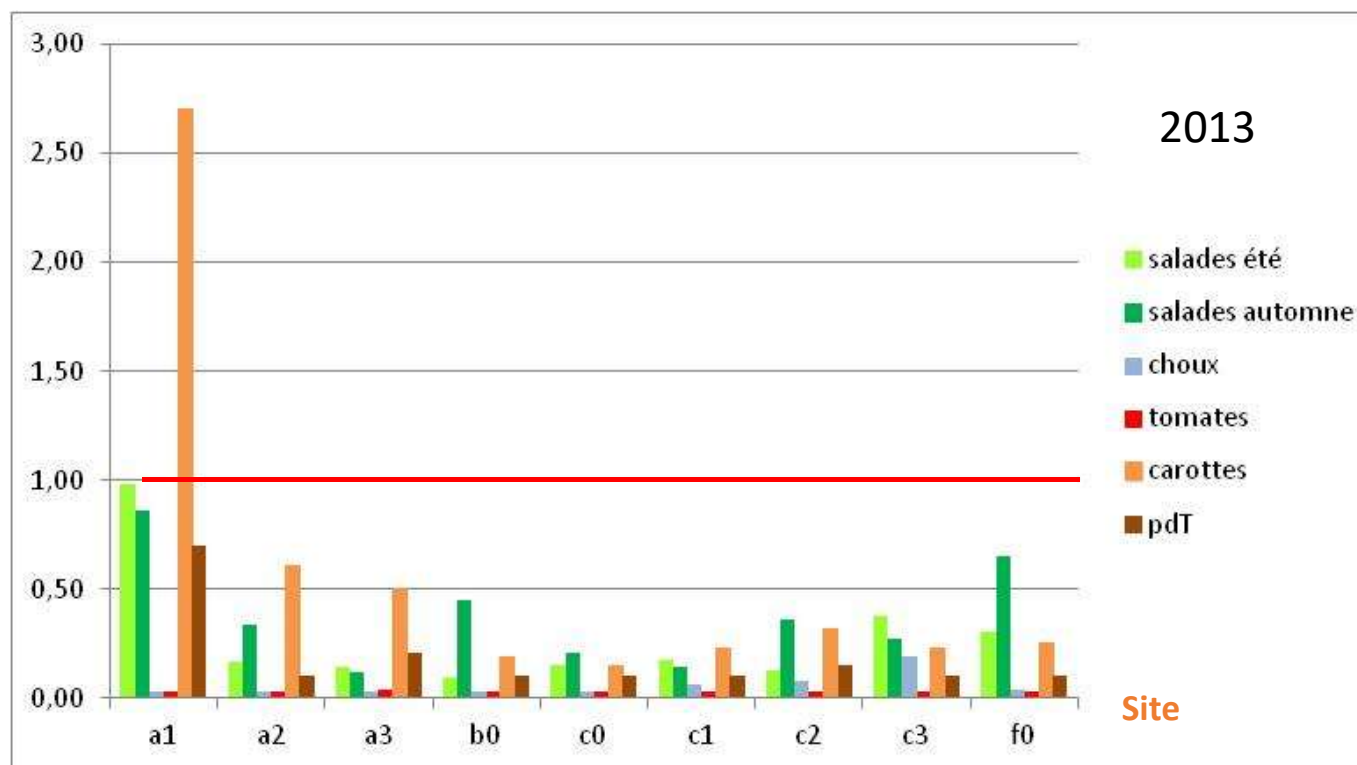
DIRECTION DES ESPACES VERTS ET DE L'ENVIRONNEMENT





Pb

[Pb] /freshold value





## Analysis of various vegetables : (vegetables washed, peeled)

- 2-3 leave vegetables
- 1 root vegetable
- 1 tubercul
- 1 froot vegetable
- 1 aromatic cultivated 3 years

→ POTEX

2012:



(or



2013:

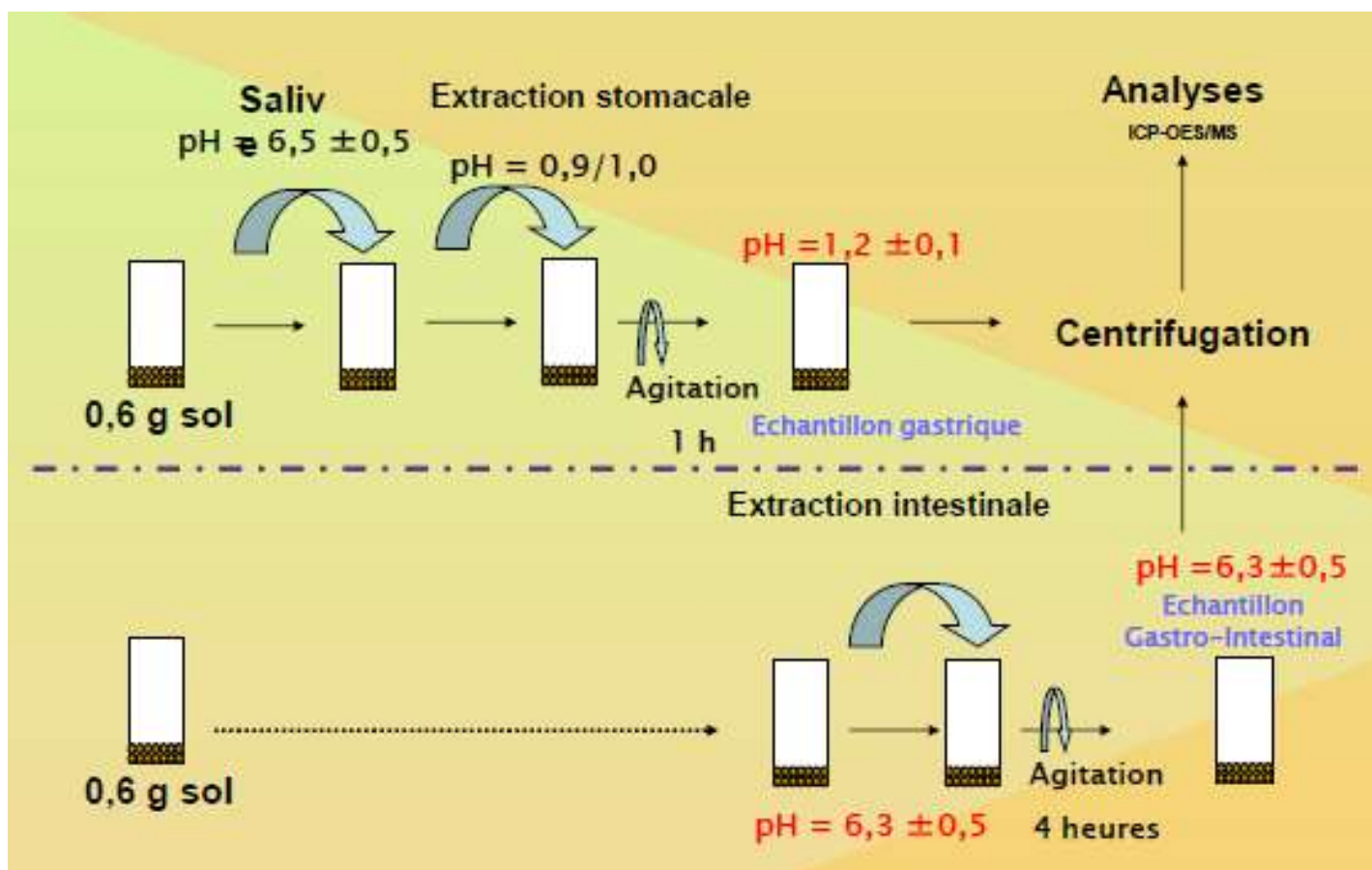


and





## Total concentrations and bioaccessibility





# Phytoremediative urban design: Transforming a derelict and polluted harbour area into a green and productive neighbourhood

M. Wilschut<sup>\*,1</sup>, P.A.W. Theuvs<sup>2</sup>, I. Duchhart

**Env. Pollution, 2013**



phyto-extraction willows and holly hedge

phyto-extraction  
fields

raised path



## 4-Case study

- 4.1-Gardens near ICPE (regulated industries).
- 4.2-Aquaponic farms.
- 4-3-Cultures on roofs / compost quality.

## 4.1-Gardens near ICPE

In urban and suburban areas, people grow plants in individual or shared gardens that can be found near roads or businesses may emit pollutants that may impact the quality of the plants.

The following publications concern that subject :

- Schreck et al. (2012, 2013, 2014), Austruy et al. (2014), Xiong et al. (2014);
- Sampling Guide plants.

([http://www.developpement-durable.gouv.fr/IMG/pdf/Guide\\_echantillonnage-avril\\_2014.pdf](http://www.developpement-durable.gouv.fr/IMG/pdf/Guide_echantillonnage-avril_2014.pdf));

BAPPET database concentrations of metals in plants.

([http://www.developpement-durable.gouv.fr/spip.php?page=article&id\\_article=19792](http://www.developpement-durable.gouv.fr/spip.php?page=article&id_article=19792))

vegetable gardens close to a car battery recycling business in Orleans.

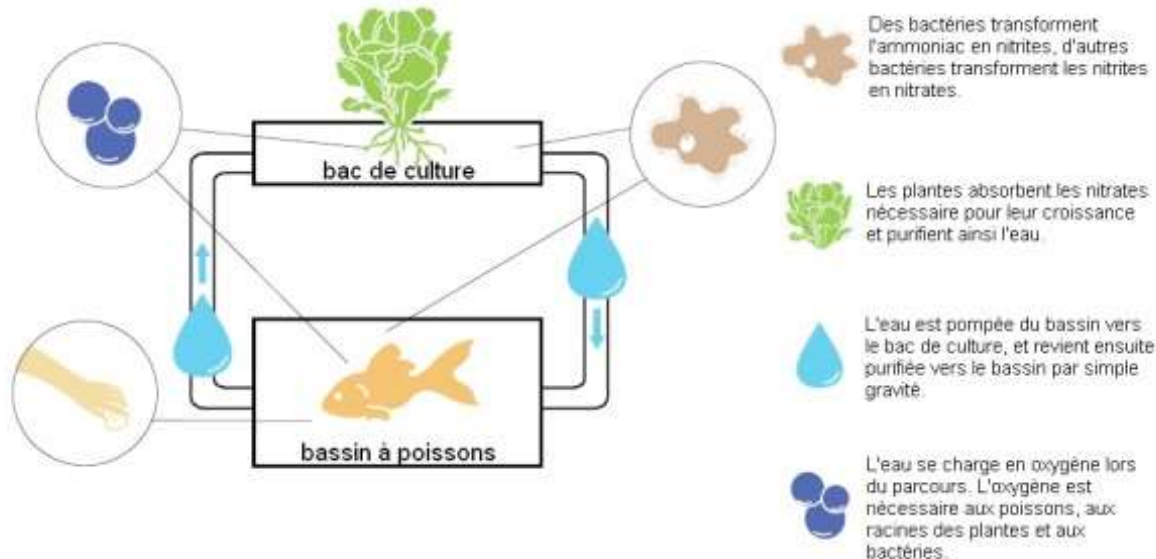
- ✓ As part of his thesis, S. Mombo conducted the study: "Metal Bioaccessibility to Improve human health risk assessment: case of Pb and Cd pollution in kitchen gardens near regulated company". Mombo et al., 2014.
- ✓ In a global context where gardening activities are widely developed in the world, even in polluted areas, the present study was carried out in order to **improve human health risk assessment and management in the case of contaminated kitchen gardens near factories**. Soils and vegetables were collected in kitchen gardens near 50 years old lead recycling regulated company; then, both total and bioaccessible cadmium (Cd) and lead (Pb) concentrations were measured. Communication to citizens of scientific results was a crucial point of this participatory program.

## 4.2-farm-container, fish + vegetables

- "Efficient City Farming" ECF Berlin startup that grows vegetables (tomatoes, chard ...) with fish.
- In the courtyard of a former brewery, container houses fish farming, wearing a greenhouse where vegetables grow.



### Aquaponie : comment ça marche ?



The Aztecs were already using aquaponics (hydroponics + aquaculture).

The plants grow on a neutral substrate (sand) irrigated; fertile soil is not useful: asset in a global context of growing urbanization.

↓ water consumption,  $\text{CO}_2$  (that emitted by the fish is used for the culture).

# aquapony

- The farm-container, which serves as a prototype demonstrator. ECF wants to sell large farms to real estate developers, businesses and farmers.

An ECF aquaponic farm will be built on 1,800 m<sup>2</sup> in 2015 south of Berlin. A shop will sell fruits and vegetables (Berliners will be delivered each week). The fish will be sold on demand. Forecast: turnover ≈ 550,000 euros per year.

At ECF, even if "all is de facto organic" production is not stamped bio (for the acronym, plants must grow in the ground). However, for fresh food, regionality is a more important purchase criterion than the bio (2013 study in Germany, Switzerland and Austria; consulting firm AT Kearney): freshness, quality and desire to support the local economy are the main consumer motivation in this choice for the "new organic".

## 4-3-Cultures on roofs / work on foliar transfers



MUSÉUM NATIONAL  
D'HISTOIRE NATURELLE



1. Culture on roofs : it's new ?

2. Experimental project « T4P »

3. Results for production, pollution, biodiversity

4. Research questions...perspectives

A long-standing practice in the South



A growing practice in the North

**Various technic systems**

Reported on ground  
on substrates  
In hydroponics, aquaponics etc..



Jardin d'insertion, Paris



Santropol Roulant, Montréal

**Various objectives :**

Familial,  
associative,  
commercial



Thornton's Budgens, Londres



Brooklyn Grange,  
New-York, 2010



Gotham Greens,  
New-York, 2011



Lufa farm, Montréal 2011





## Why developing roof top gardening

The lack of vacant areas  
« on the ground »

The fear of polluted soils  
Due to past activities

The huge demand for  
local products

A growing interest  
of cities for

*Facing the growing demand for  
self production spaces in dense  
urban areas*

*The roof conquest is perhaps the  
simplest way to face this problem*

*“In terms of **rooftop commercial agriculture**, New  
York is definitely a leader at this moment,” said Joe  
Nasr New York Times, 12:07/2012*

- Food strategies
- *Other ecosystemic services* (reduction of GES, heat, rain captation etc.;
- *Contribute to social links* (associative gardens, borough or building social life...)

What cultivate? →

- \* Participate in the food supply of households, businesses
- \* In one of the city?

Make products "ultra fresh" circuits "ultra-short"

### Some common questions

What cultivate?  
Soil or not?  
Weight, origin, cost

How to grow  
(crops, inheritance,  
fertilization, water, fight  
against aggressors ..)

With what results and risks  
related to the urban  
environment ?

*In Paris, about 314 ha of "roofs plantable" do not 80 "potentially cultivable"  
(données Régnier et Tasso 2011, APUR-Mairie de Paris 2012)*

## The Project T4P: several positions are taken



Technical easily appropriated by associations, individual "mimic an associative garden"

Systems without greenhouse or hydroponic system

Participate in the "urban metabolism" (Barles, 2005)

Cultivating on LOCAL urban organic waste products.

Explore substrate engineering (support AgroParistech Scientific Council)

Develop a repeatable experiment.

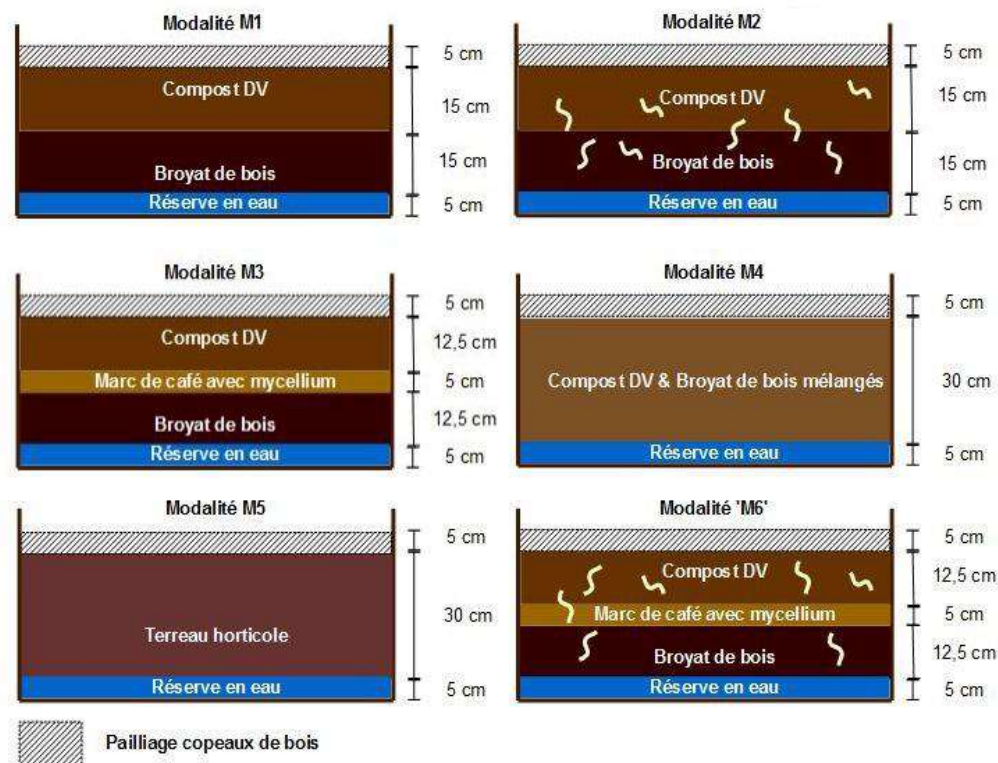
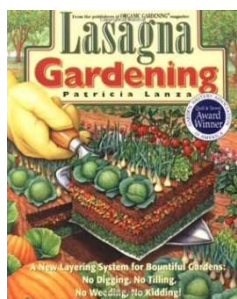
### Studying :

- Levels of production
- The operation of the substrates (dyn EM, water ..)
- The levels of pollution (air, substrates, products).

# Characteristics of a suitable substrate :

Lightness, local availability, agronomic performance, Sustainability

Systems Lasagna  
(Collaert, 2010)



culture successions S1 = lettuce and cherry tomatoes;

S2 = cherry tomatoes and lettuce

15 containers with  
succession

5 treatments

3 containers  
for each  
treatment

5 lettuces or 4  
tomatoes / container

## Questions on environmental services

Impact on biodiversity in the city?

Closing urban nutrient cycles?

Impact on reducing greenhouse gas emissions (GES) by reducing food transportation?

Impact on reducing urban heat islands?

Impact on the absorption of rainwater

And all this, especially in comparison with other uses of urban roofs which non-productive vegetation ...

# 5-Conclusions & Perspectives

- 5.1-Conclusions
- 5.2-Naturopolis
- 5-3-Further information...



## 5.1-Conclusions

- ↑ → urbanization likely developments of the UA both intra and peri.

Two dilemmas:

(1) the suburban land facing the ↑ of demand for construction:  
antagonism?

(2) the intra-urban: competing or complementary to the suburban?

Technical choice: biological agriculture or not, hydroponics or not,  
diversity of cultures and systems?

Questions:

- (i) channels (self-production or sale)
- (ii) insertion in urban interstices ... and on buildings,
- (iii) Environmental: more research in logistics, etc.



## 5.2-NATUROPOLIS: THEY SEE THE TOWN GREEN



- Over half of humanity now lives in cities and in parallel, the flora and fauna are investing more and more urban settings.

Surprising consequence: relations between men and animals have never been so rich! You find that your city is still not enough green? Our participative website Green Guerilla gives you the tools to act!

LE RÉSEAU GREEN GUERRILLA

# Naturopolis : the documentary series

- How megacities trying to reconcile with nature?
- This is the question that arises Naturopolis, documentary series in four parts, through a broad reflection on the environmental challenges ahead.
- For the first time, exploration of biodiversity is at the heart of the city and human activities. More than a spontaneous movement, a worldwide environmental movement that unites citizens, politicians, scientists, artists, architects ...

- ❖ [Rio](#) : from chaos to the sustainable city. Teeming with activity 12 million people exposed to rising sea levels and uncontrolled urbanization nibbling the mountain, the Brazilian megacity now lives under the constant threat of flooding and deadly collapses.
  
- ❖ [New York](#), the green revolution. How a megalopolis like New York prepares this mutation and reintroduces the well living in the city and how she anticipates the environmental challenges of the twenty-first century? Why to survive, New York is obliged to invent a new pact with the environment, agreeing to make its "sustainable" revolution?
  
- ❖ With two million urban beings and only five square meters of green space per inhabitant, [Paris](#) is one of the densest and least green cities in the world. While the capital has long pushed nature beyond its walls, she now realizes his indispensability.
  
- ❖ [Tokyo](#), the megacity in the garden city. Tokyo, the largest metropolis in the world is changing. Fukushima has sounded the end of a myth: that of easy energy and endless growth. Today, the city is considering a different development model. Now the people of Tokyo are beyond the rank and calling other models for their concrete city. The aspiration to nature has become central; it will cause the metamorphosis of the city.



## 5.3-FOR FURTHER...



- Réseau-Agriville: <http://reseau-agriville.com/> (courses on various forms of urban agricultures, soils, regulation, etc. are available).
- <http://www.terresenvilles.org/missions.php>
- Les jardins sur les toits, de nouveaux espaces pour la communauté ; <http://www.rooftopgardens.alternatives.ca/>.
- [http://fr.ekopedia.org/Agriculture urbaine](http://fr.ekopedia.org/Agriculture_urbaine)
- Des Cultures et des villes, 2013 - documentaire de Jean-Hugues Berrou produit par AgroParisTech, 53' - expériences d'agriculture urbaine à Paris, Berlin, New York et Montreal - <http://www.dailymotion.com/video/x1683p2>.
- Wu et al. 2015. Synergistic improvement of crop physiological status by combination of cadmium immobilization and micronutrient fertilization. Env. Sc. Pollution Research.
- <http://www.ruaf.org/urban-agriculture-what-and-why>
- <http://12.000.scripts.mit.edu/mission2014/solutions/urban-agriculture>
- <http://www.sustainabletable.org/251/innovative-agriculture>
- <http://www.who.int/ipcs/features/cadmium.pdf>
- [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/313899/SCHO0709BQRO-e-e.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313899/SCHO0709BQRO-e-e.pdf)