# The future of urban agriculture from a social and metabolic perspective

The second Edible City Network Conference
17/03/2023

https://urbag.eu/

EXCELENCIA MARÍA DE MAEZTU

icta

UAB Universitat Autònoma de Barcelona

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Objectives of the workshop

To present a comprehensive vision of the current urban agriculture challenges and opportunities, by considering both social and environmental perspectives, while employing the Metropolitan Area of Barcelona as case study

To discuss and weight how relevant are the urban agriculture impacts observed in the Metropolitan Area of Barcelona.

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Agenda

| | |
|---|---|
| 11:40 | Start-up business for the implementation of urban agriculture<br>(Verónica Arcas/Tectum Garden & ICTA-UAB) |
| 11:48 | Social perspective of urban agriculture: drivers and obstacles<br>(Johannes Langemeyer/ICTA-UAB) |
| 11:54 | Metabolic perspective of urban agriculture<br>(Gara Villalba/ICTA-UAB) |
| 12:01 | Potential of nutrient recovery from the organic municipal solid waste<br>(Juan Arosemena/ICTA-UAB) |
| 12:10 | Q&A |
| 12:20 | Urban agriculture in the AMB: potential changes in vulnerabilities<br>(David A. Camacho/ICTA-UAB) |
| 12:30 | Participatory exercise |

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Tectum Garden:

the development of a start up business for the implementation of urban agriculture

Tectum sostenipra Universitat Autònoma de Barcelona Parc de Recerca UAB CSIC IRTA UAB


Team
Tectum

spin-off UAB

# Tectum garden

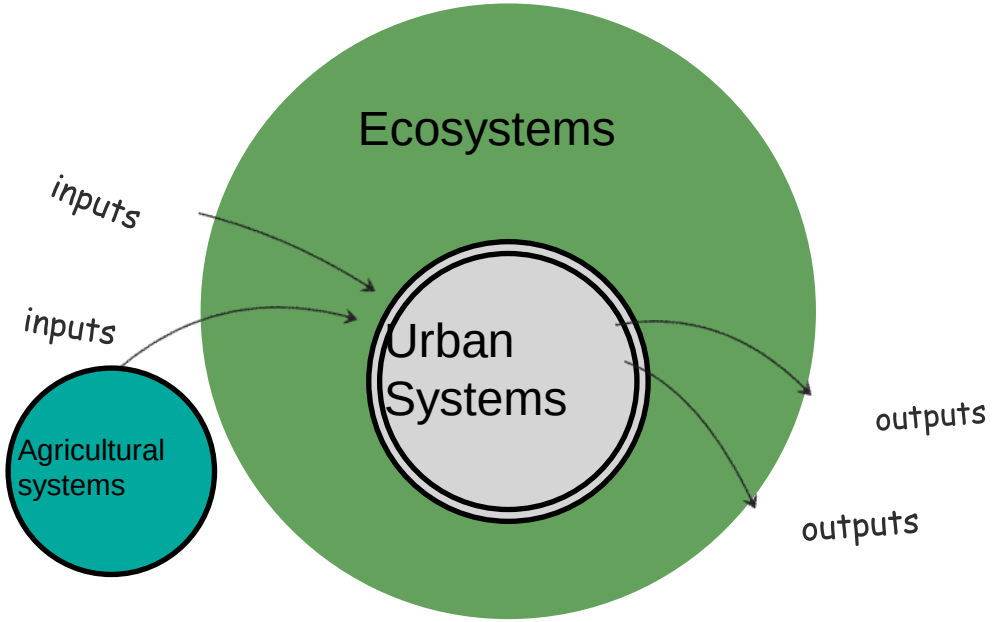
UAB icta

sostenipra


Mission
Tectum

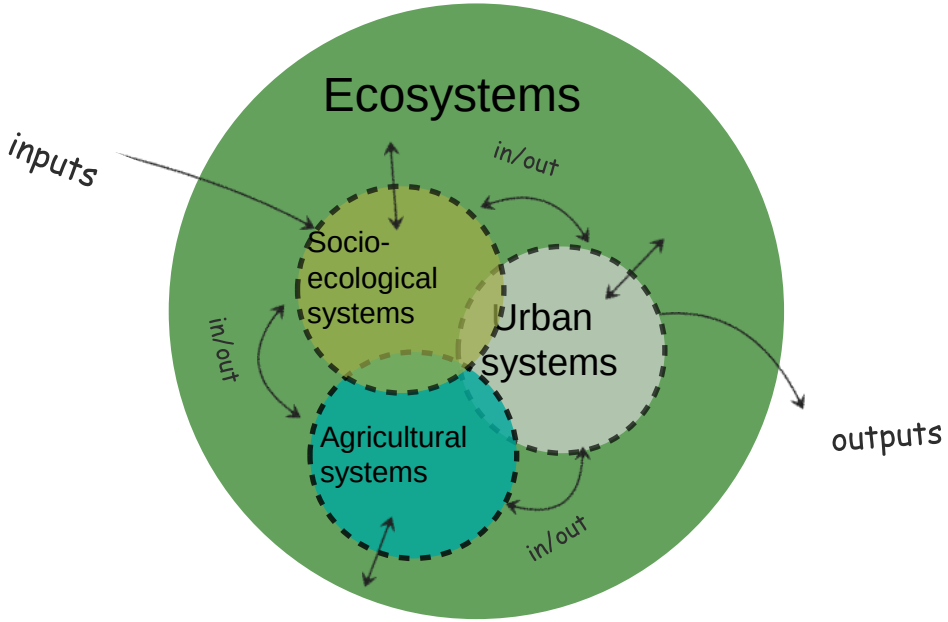

**Tool to improve the circularity of resources and sustainability in cities.**

Agriculture and technology meet society.




Convencional systems

**ISOLATED**




Integrated systems

**PHYSIC AND DINAMIC CONNECTIVITY**


**→Not only production oriented benefits**

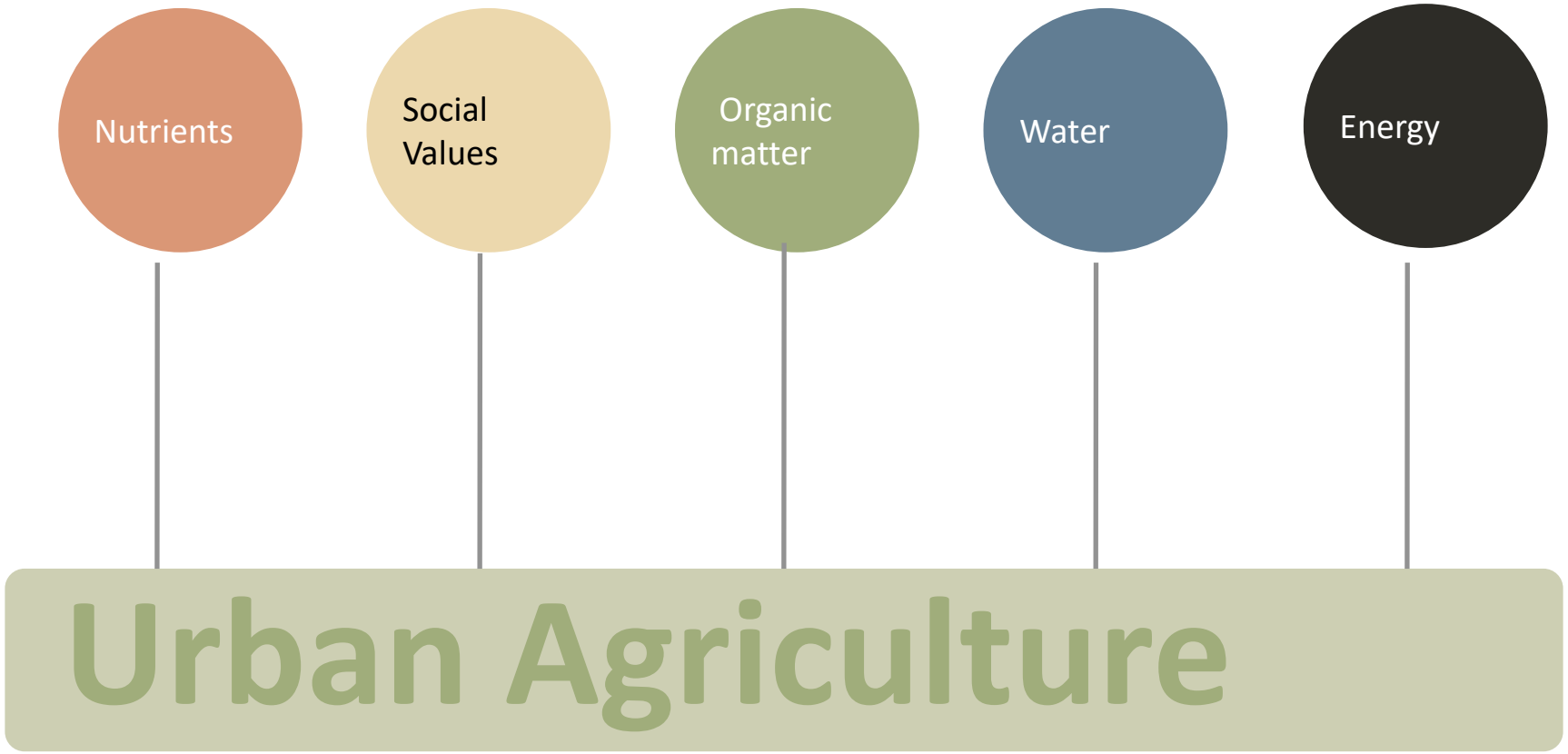
**→Tools to transform dense cities**

**→Gives urban landscapes a wide range of functions**

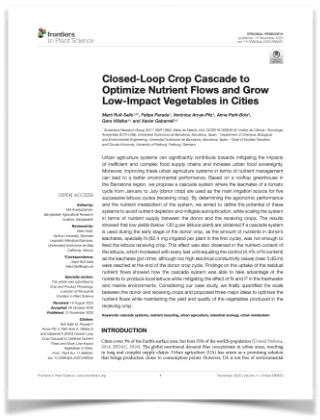
**Multiple social and ecological benefits**

(Gorgolewski et al. 2011; Lovell 2010; Zande 2006; Sartoux and Rosenstiehl 2008; Sartoux 2008)

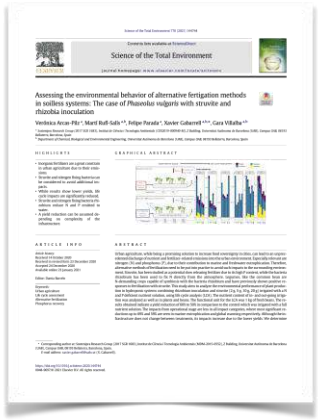
Agriculture for people


Nutrients
Social Values
Organic matter
Water
Energy
Urban Agriculture

Identifying eco-efficient year-round crop combinations for rooftop greenhouse agriculture



Closed-Loop Crop Cascade to Optimize Nutrient Flows and Grow Low-Impact Vegetables in Cities



Science of the Total Environment

Assessing the environmental behavior of alternative fertigation methods in soilless systems: The case of *Phaseolus vulgaris* with struvite and rhizobia inoculation

Renewable Energy

Quantifying energy symbiosis of building-integrated agriculture in a mediterranean rooftop greenhouse

Nutrients

Social Values

Organic matter

Water

Energy

# Urban Agriculture

Case study:
Rooftop greenhouse
ICTA-UAB Building

case study 1

case study 2

Nutrients

Social values

Organic matter

Water

Energy

**Tectum Garden**

IBERITAL

Escribà AGROECOLOGY PROJECT

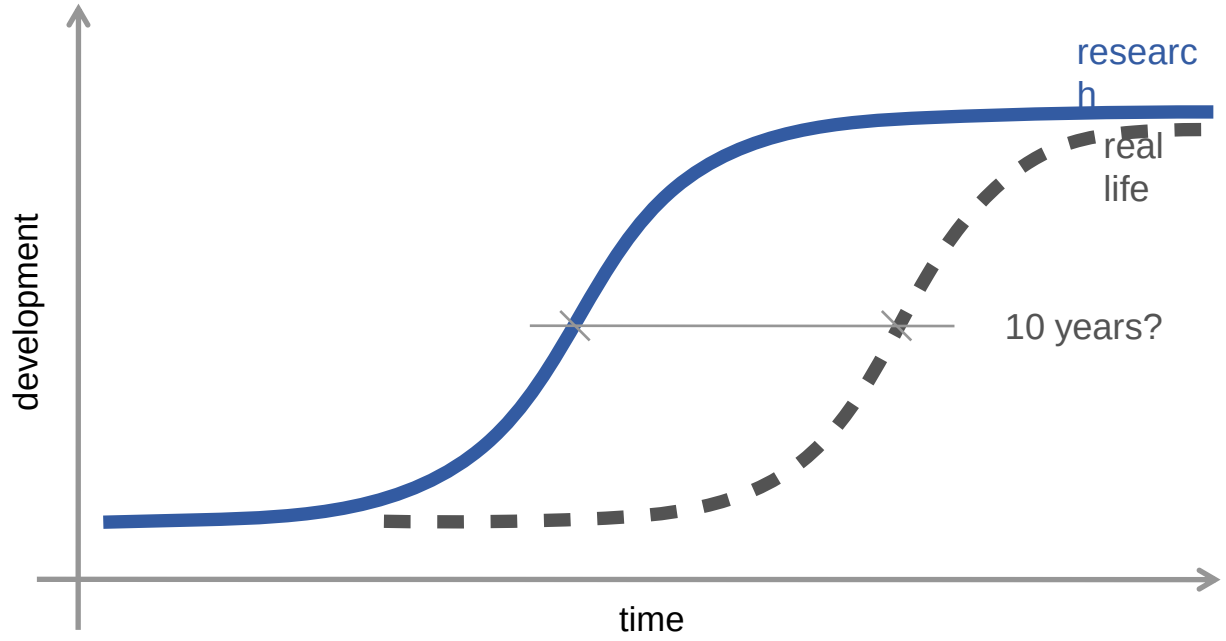
**Robert Strauss** Barcelona

**AcDO** Madrid

Knowledge transfer


icta
UAB
Universitat Autònoma
de Barcelona

# A timescale problem




- Research is prospective = important to continue feeding it
- Time gap = transition towards sustainable urban models
- Contradictions with global changes

Projects

Tectum

# Ongoing and finished projects

IMPD, Barcelona
Urban Agriculture maintenance project,
with the Institute of Disabled People of the
Barcelona City Council

Tectum

IMPD-Glòries, Barcelona
IMPD and BARCELONA COUNCIL ARCHITECTURE,
social Urban Agriculture project for the use of rainwater and food production
with studio9am


incorporació
+CIRCULARITAT

energia

persones

aliments

aigua

residus orgànics

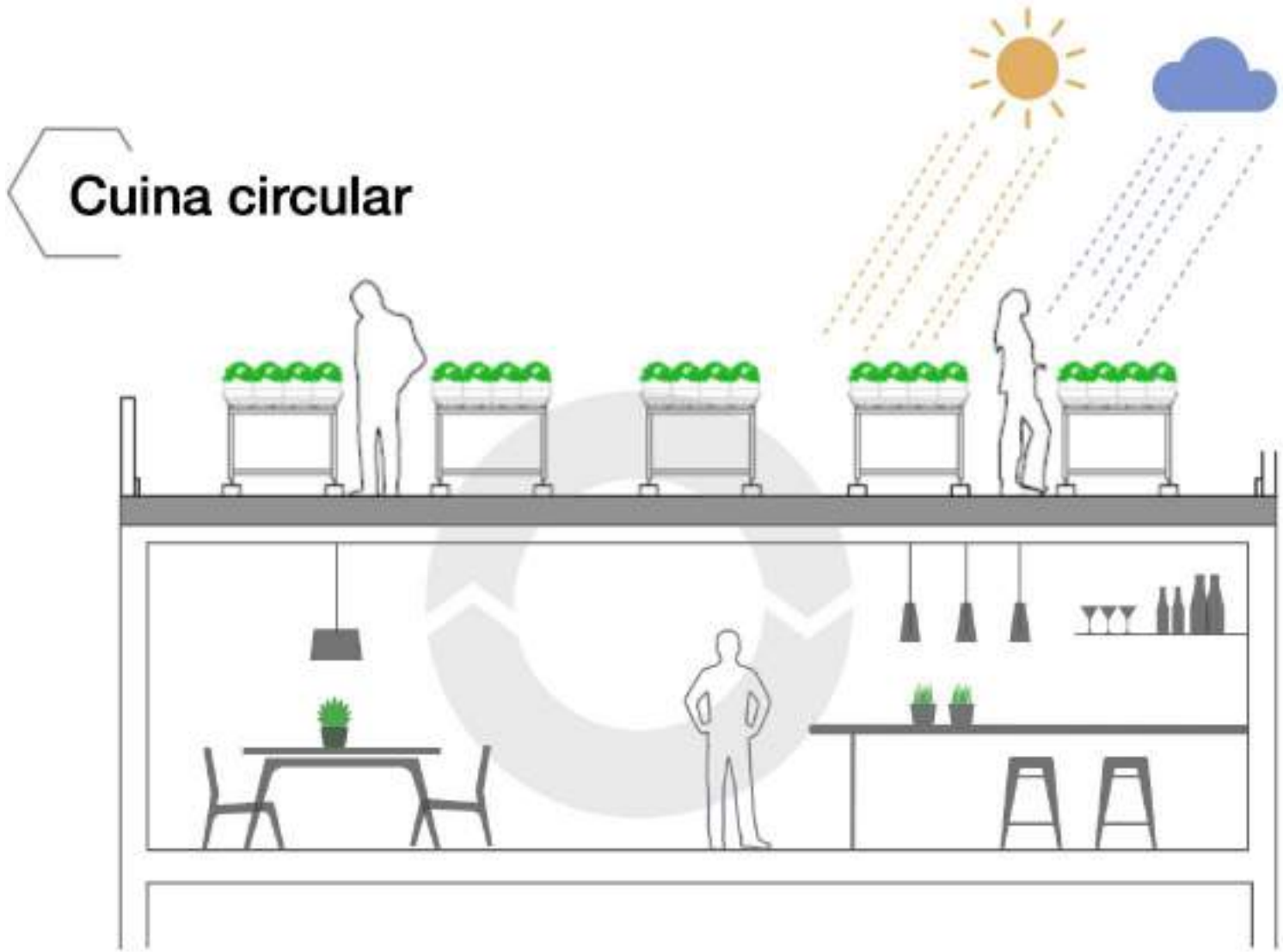
materials

Escribà Restaurante, Girona
Restoration Project

Tectum

sostenipra

# Cuina circular



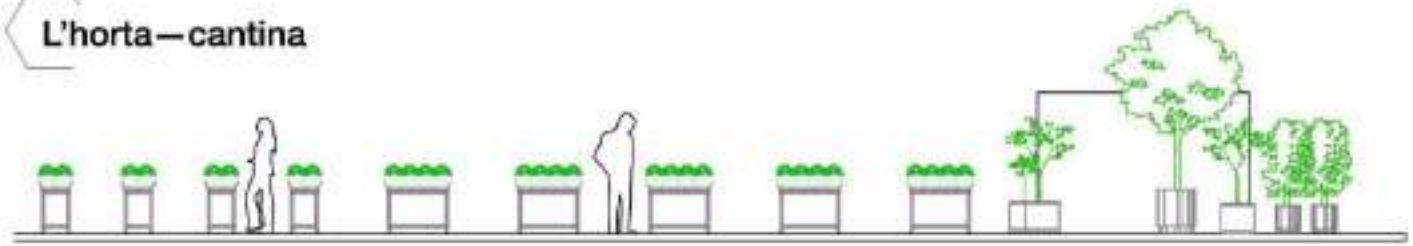


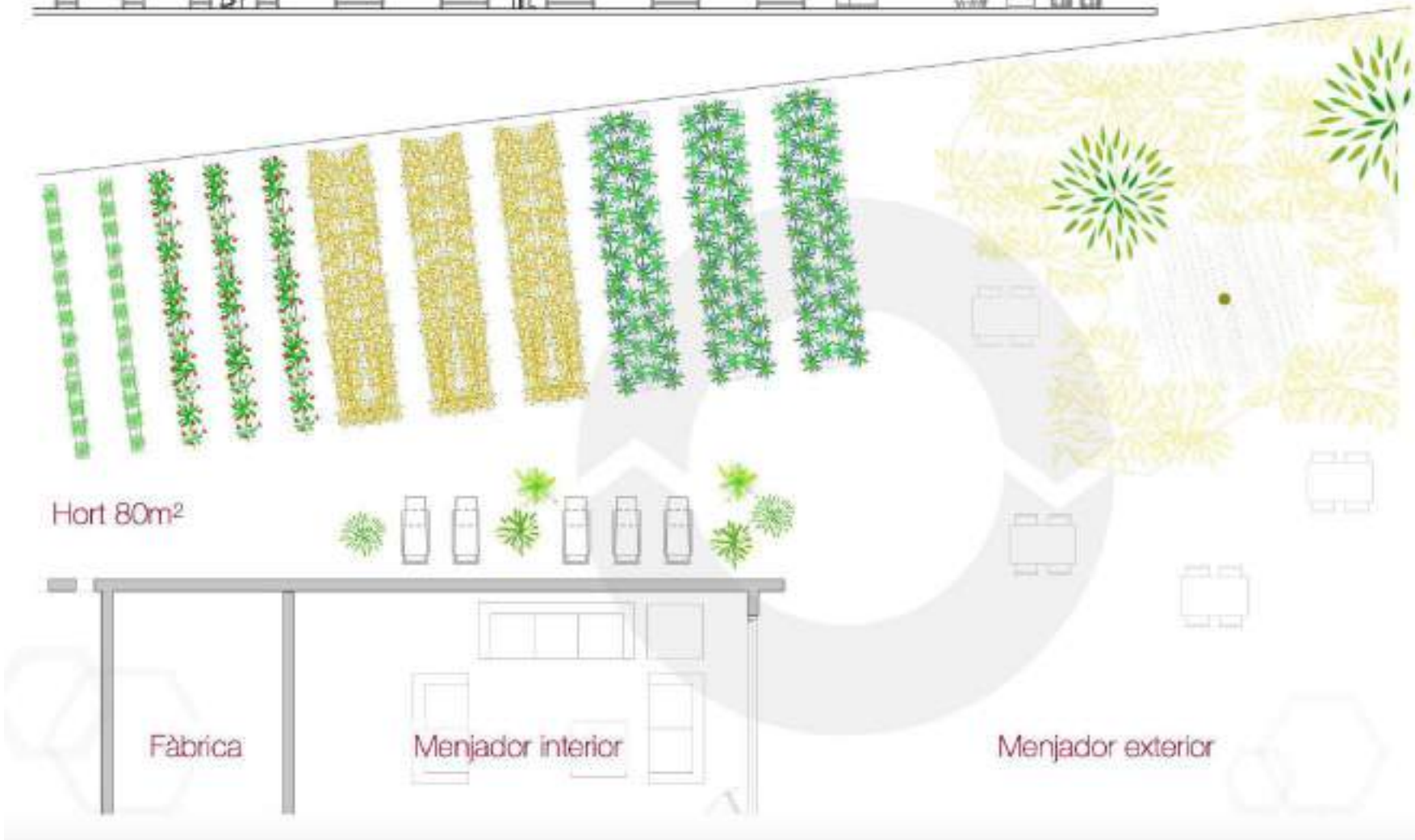
IBERITAL, Barcelona
ELECTRICAL SECTOR COMPANY, AU
canteen project for workers

Tectum

sostenipra

# L'horta—cantina





Módulo REGREEN, CETAQUA VEOLIA
Urban Agriculture demonstration greenhouse project using regenerated wastewater



Hort urbà
regat amb aigua
regenerada
REGREEN

Proyecto Mueble kettal,
Urban Agriculture indoor furniture project.
with Kettal and Studio9am



Tectum

kettal

Proyecto SIRAH
Smart irrigation Project with the research group Sostenipra




SIRAH

MINISTERIO DE CIENCIA E INNOVACIÓN

Financiado por la Unión Europea NextGenerationEU

Plan de Recuperación, Transformación y Resiliencia

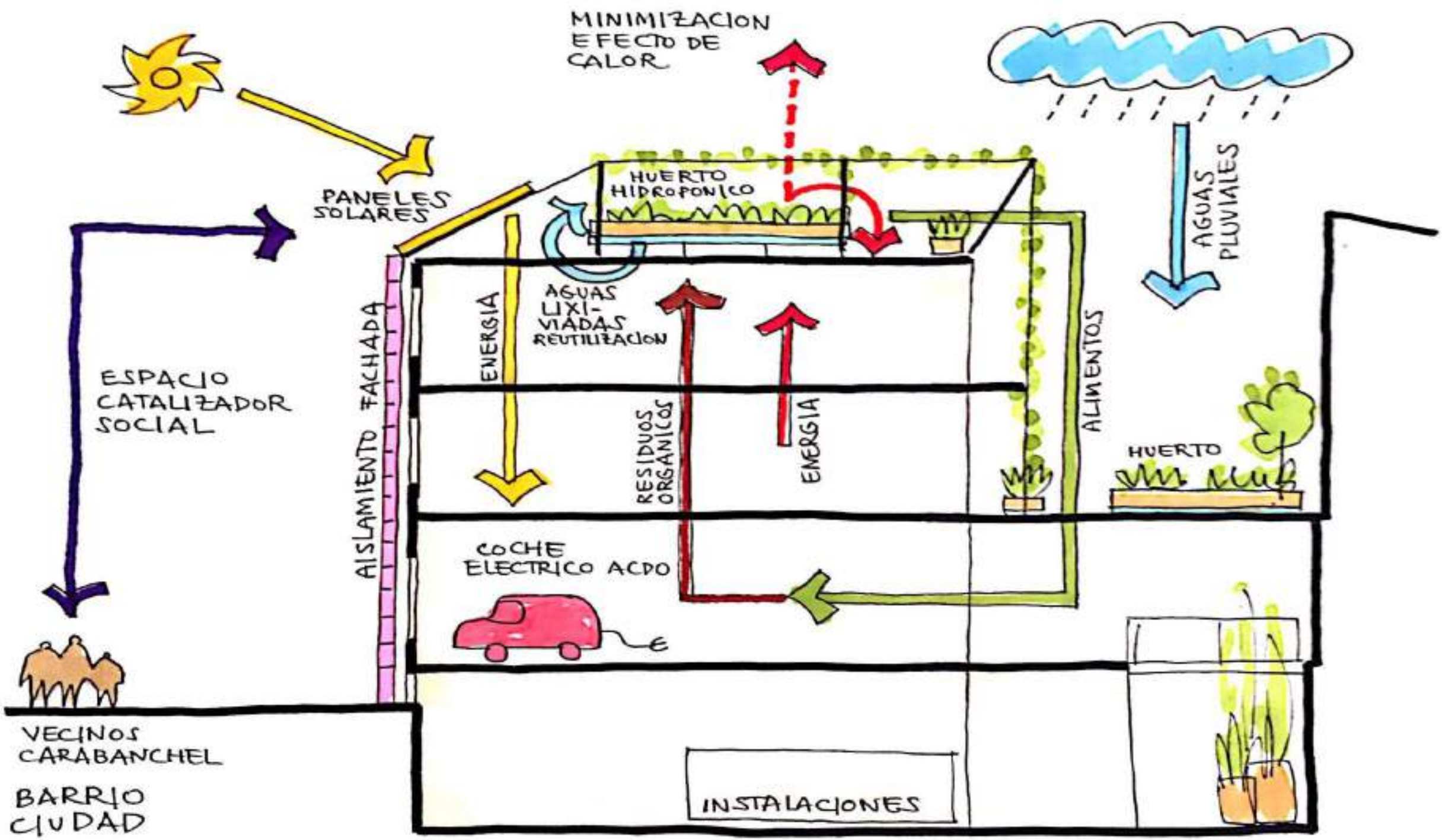
# Smart irrigation prototypes

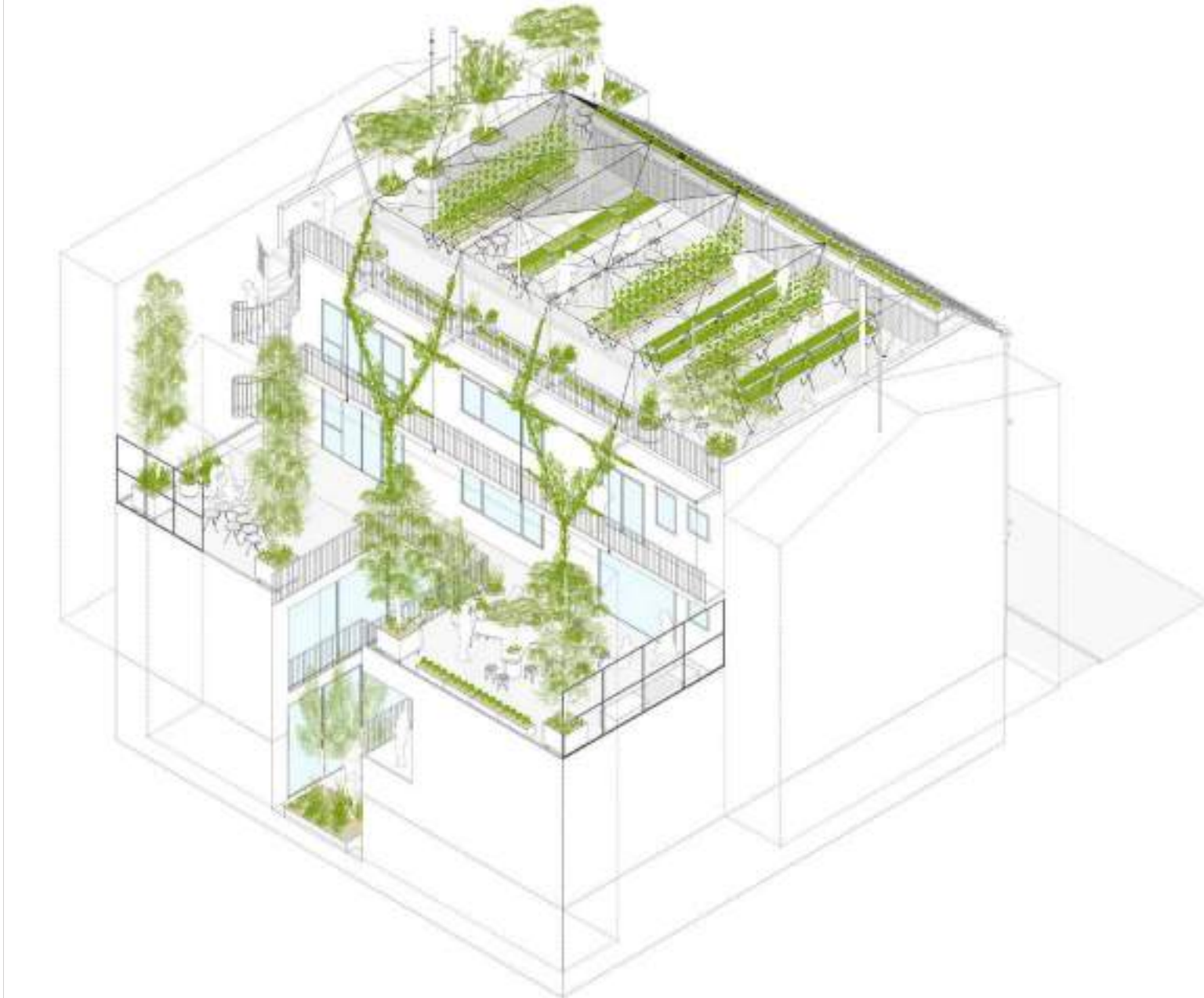

Projects

Tectum

# Future projects

Proyecto ACdO
ACDO DESIGN COMPANY
Mosaic roof project using water, energy and food
with Studio9am, ACdO



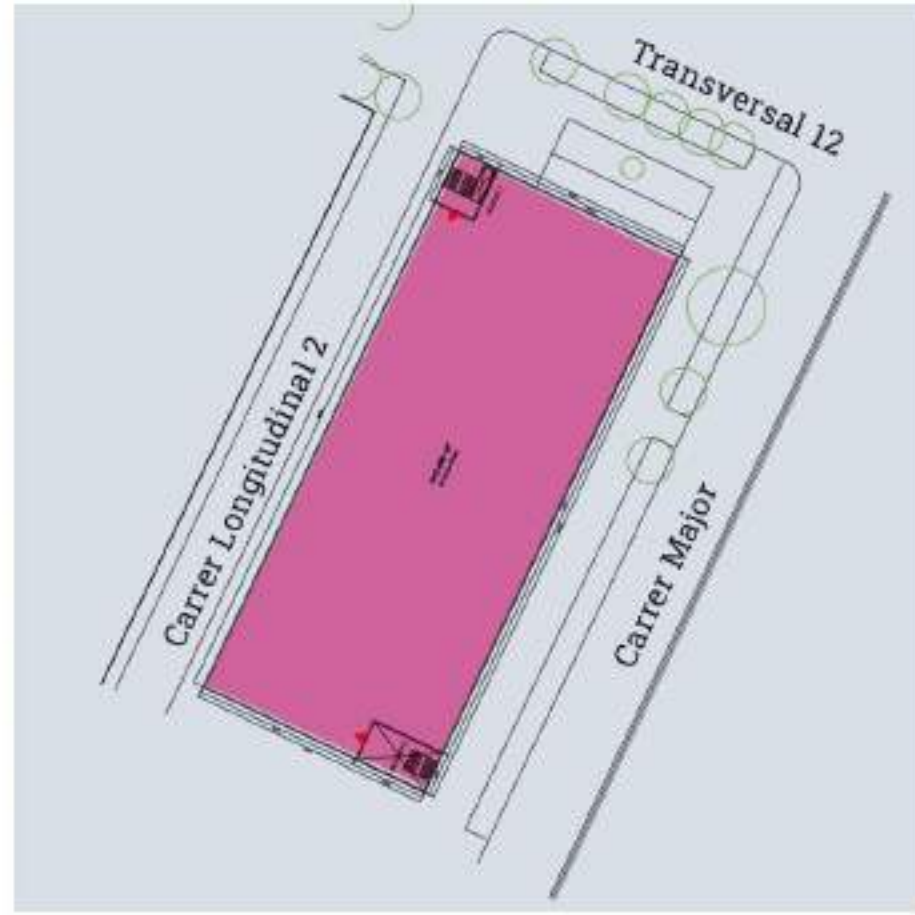
© 9am Studio / Tectum Garden / Álvaro Catalán de

© 9am Studio / Tectum Garden / Álvaro Catalán de Ocón

Proyecto Mercabarna,
MERCABARNA FOOD LOGISTICS COMPANY.
Energy mosaic roof project, intensive food production in open air and greenhouse
with Studio9am

Tectum

9 AM

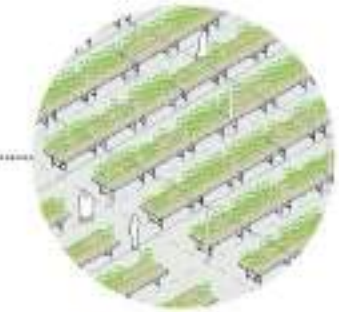

Transversal 12
Carrer Longitudinal 2
Carrer Major

# Propuesta de sistema y subsistemas

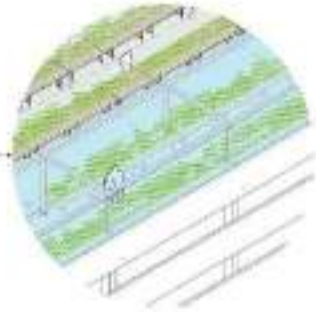
En estos gráficos se muestra un esquema básico de disposición para la cubierta de Mercabarna identificando los elementos potenciales con los que llevar a cabo su transformación.

## Agua
Recolección de agua de lluvia y atenuación de caudales de tormentas

## Energía
Paneles fotovoltaicos y espacios auxiliares



## Alimentos
Producción agrícola al aire libre utilizando principalmente sistemas hidropónicos

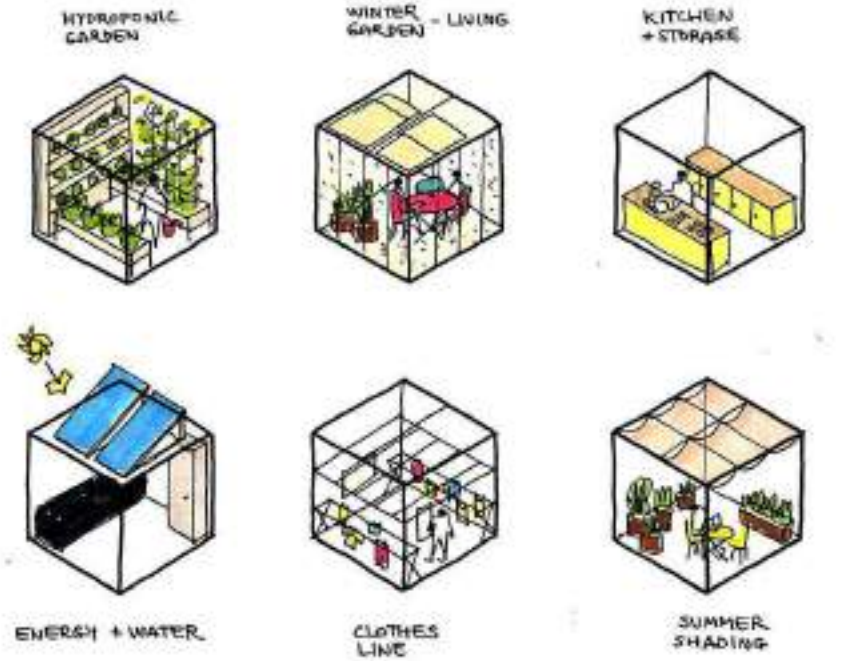


## Invernaderos
Producción intensiva de cultivos específicos

## Áreas de trabajo
usos asociados: sociales, divulgativos, escolares, formación, etc.

Proyecto Bithabitat,
BARCELONA CITY COUNCIL
COMPETITION
Multifunctional greenhouse module Project
with Studio9am, Serenovables and kettal.




HYDROPONIC GARDEN
WINTER GARDEN - LIVING
KITCHEN + STORAGE
ENERGY + WATER
CLOTHES LINE
SUMMER SHADING

Tectum

Gràcies

info@tectumgarden.cat

EXCELENCIA MARÍA DE MAEZTU

ICTA Institut de Ciència i Tecnologia Ambientals - UAB

# Spatial-temporal Dynamics and Leverage Points of Agricultural Transitions

*The case of the Metropolitan Area of Barcelona*

## The Edible Cities Network Conference 2023

Johannes Langemeyer

17 March 2023

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

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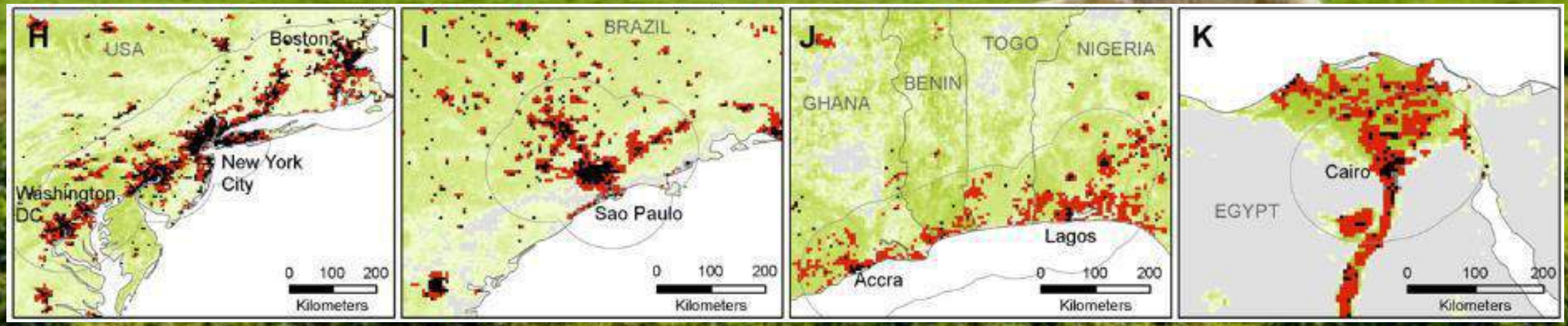
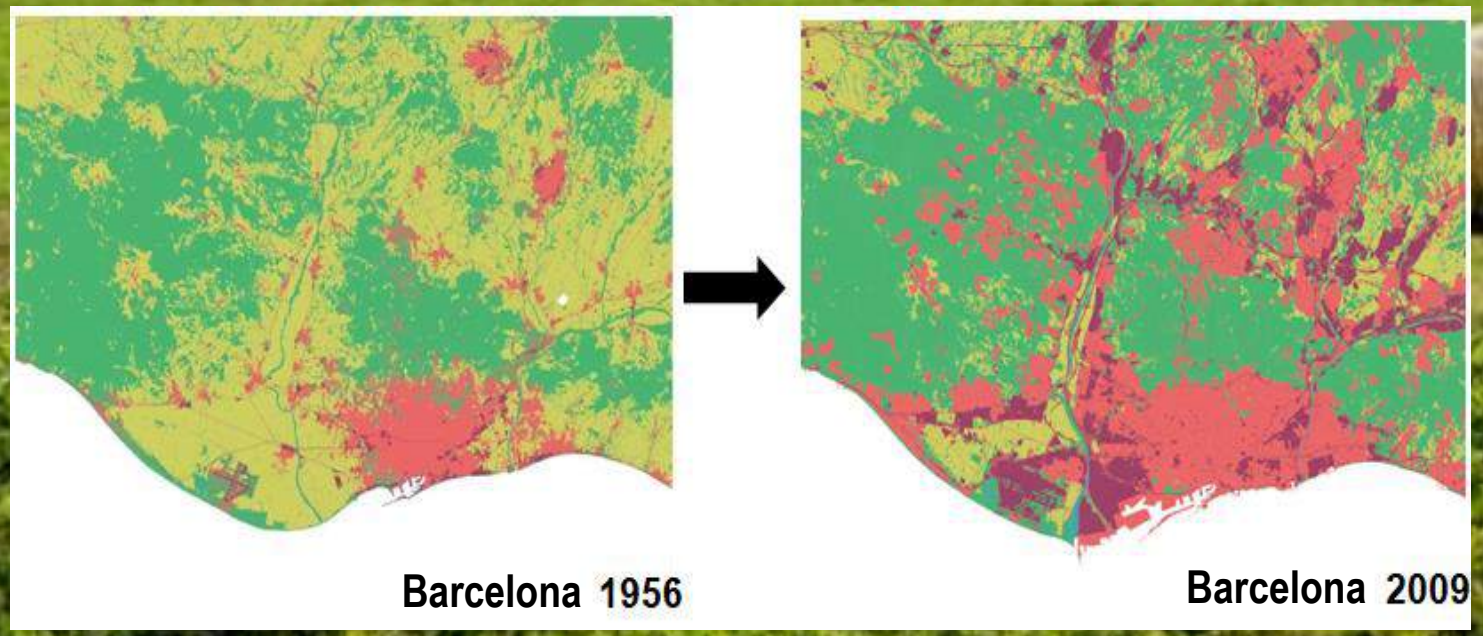
**Future urban expansion will take place in areas currently under cultivation.**

Bren d'Amour et al., 2017

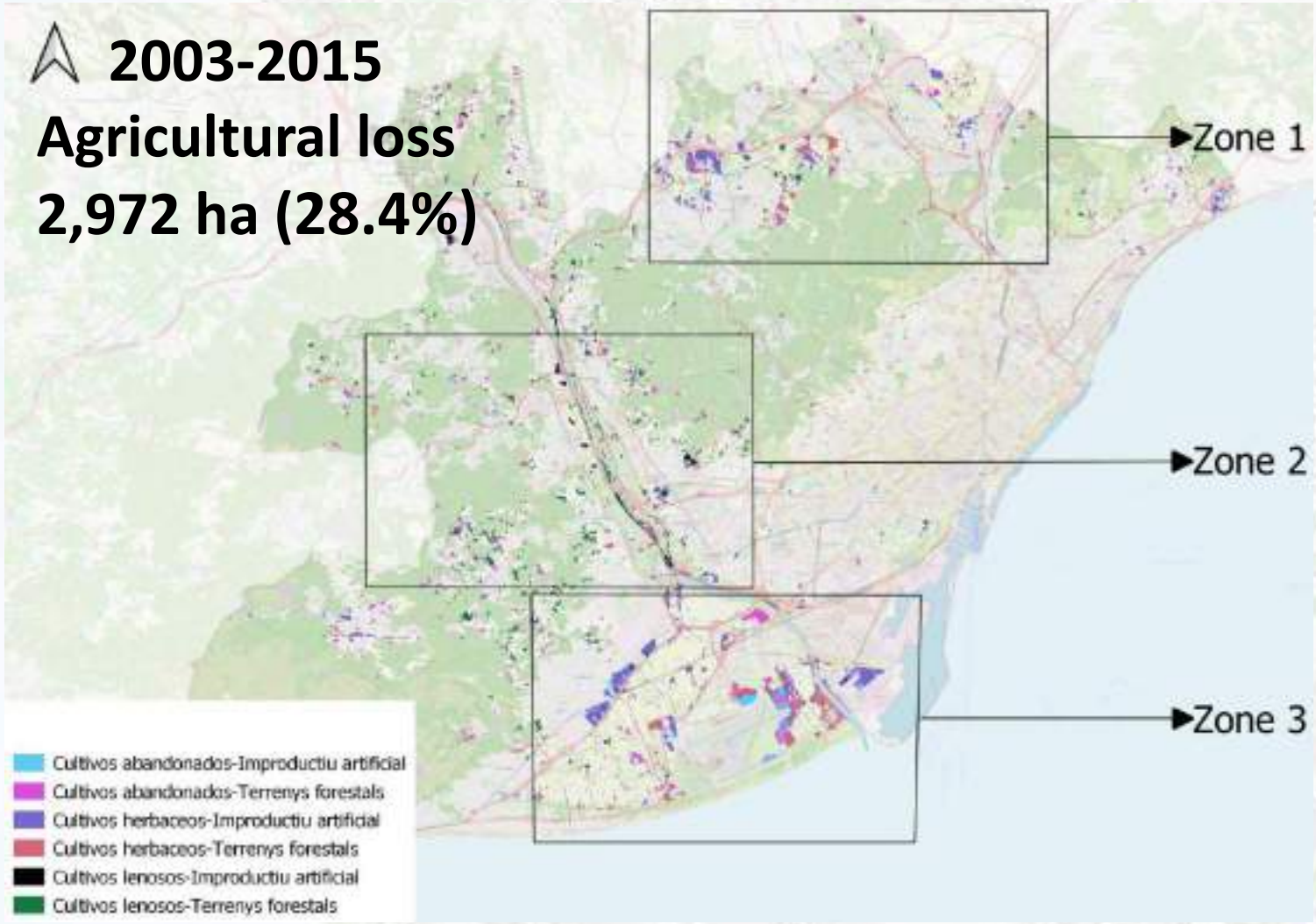


# Future urban expansion will take place in areas currently under cultivation.

Bren d'Amour et al., 2017



# Metropolitan Area of Barcelona



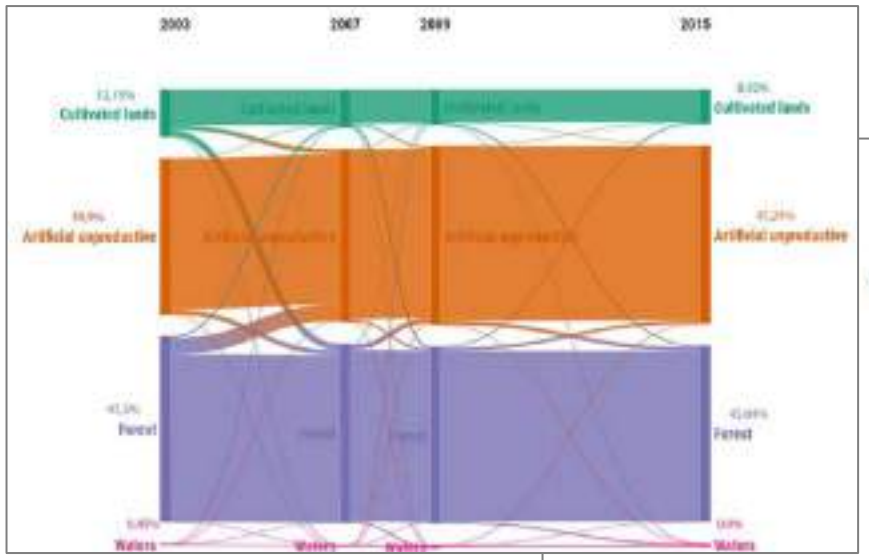

**El Vallès Occidental**

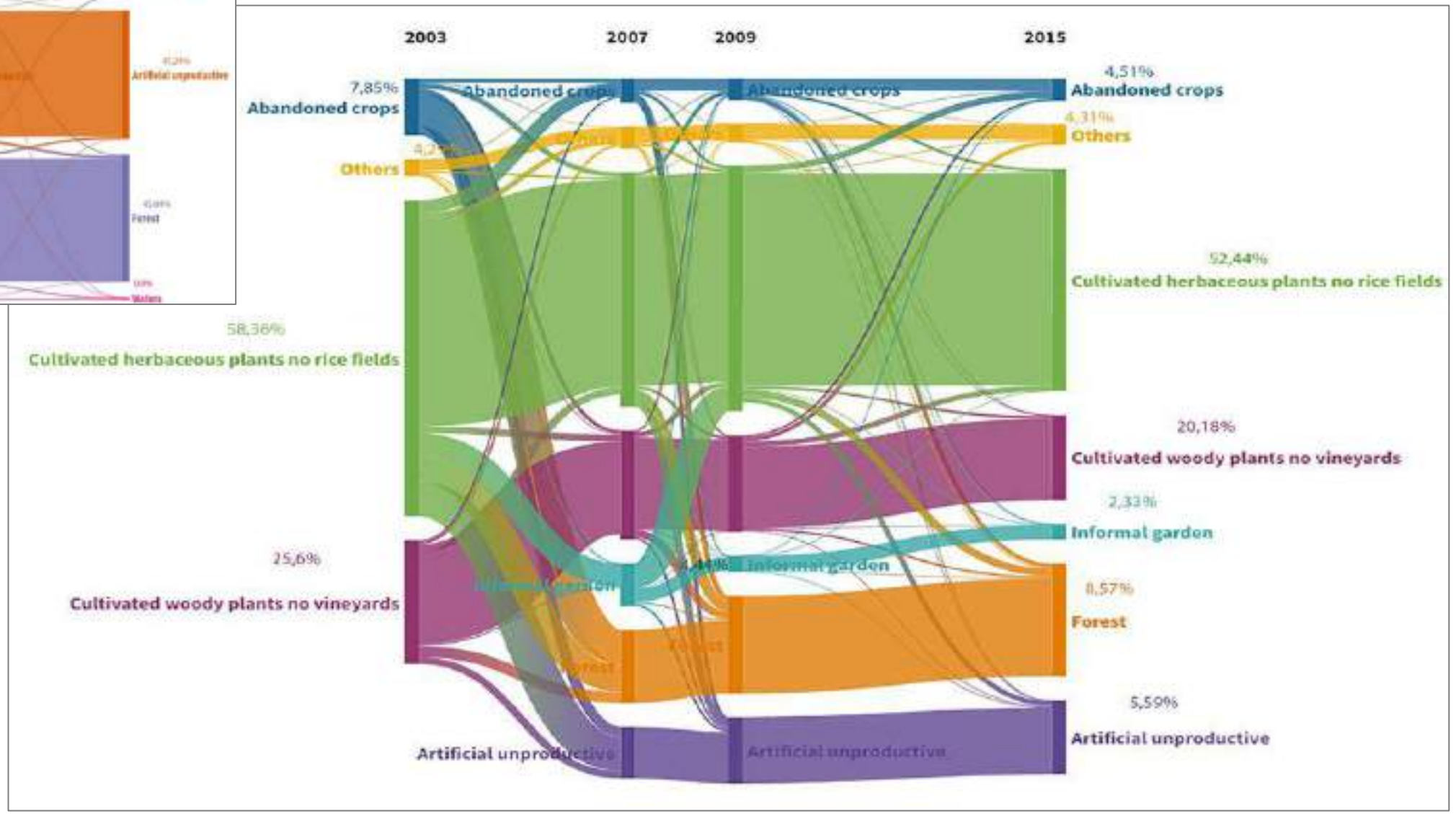
**Conca del Llobregat**

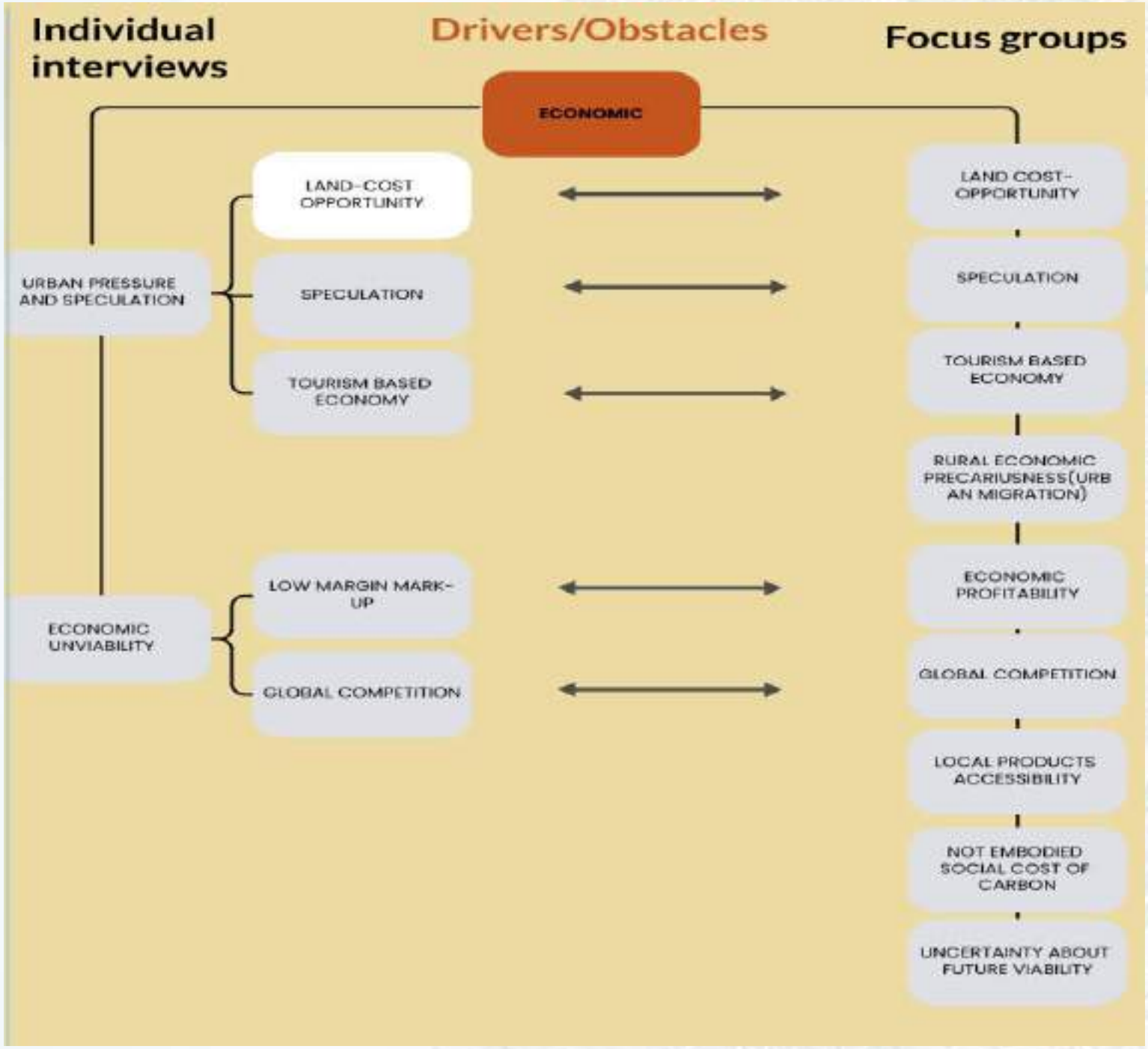
**Delta del Llobregat**

*Based on land-cover maps by CREAF (2003, 2007, 2009, 2015)*

# Superficie agrícola en el Area Metropolitana de Barcelona

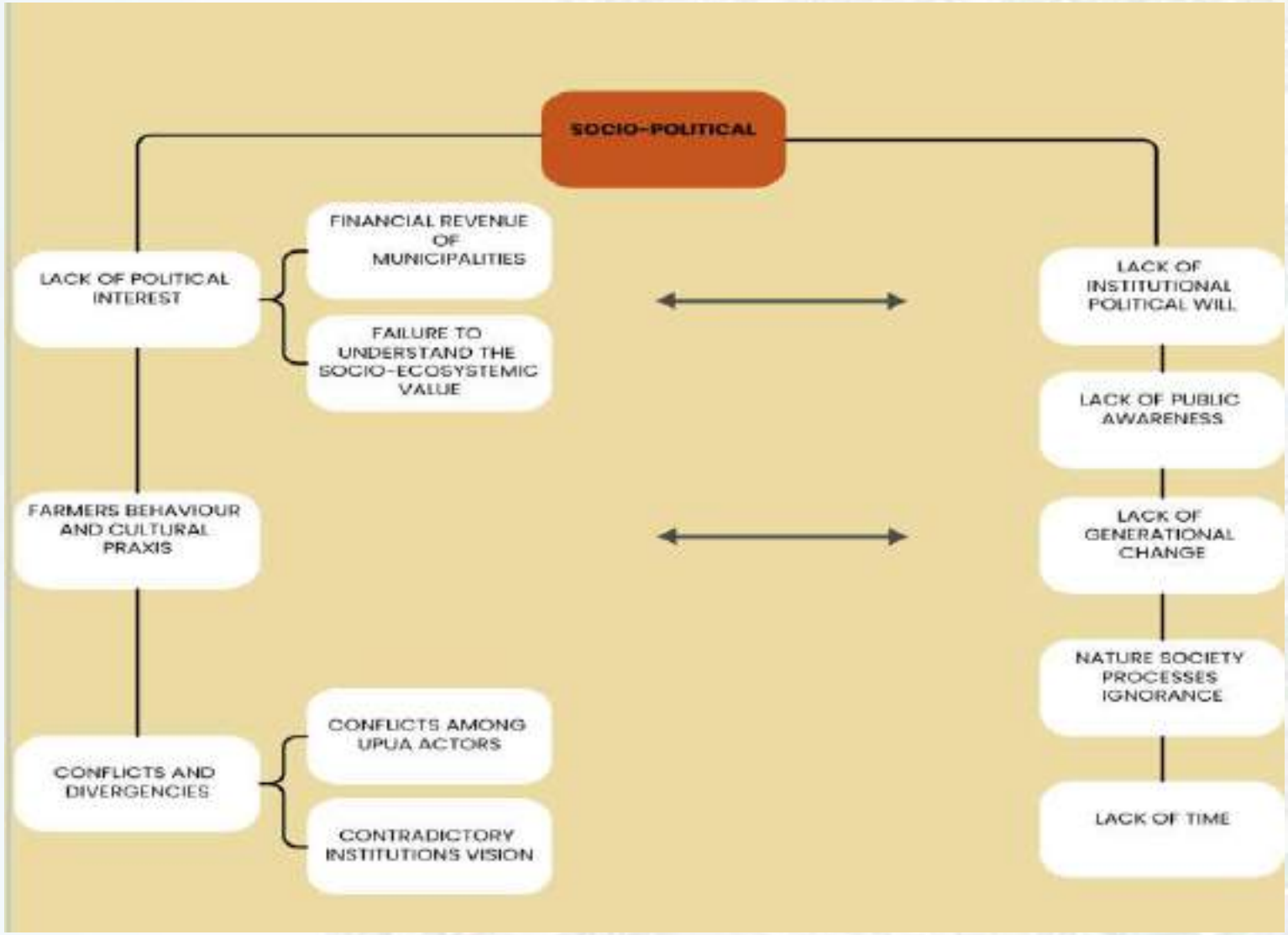




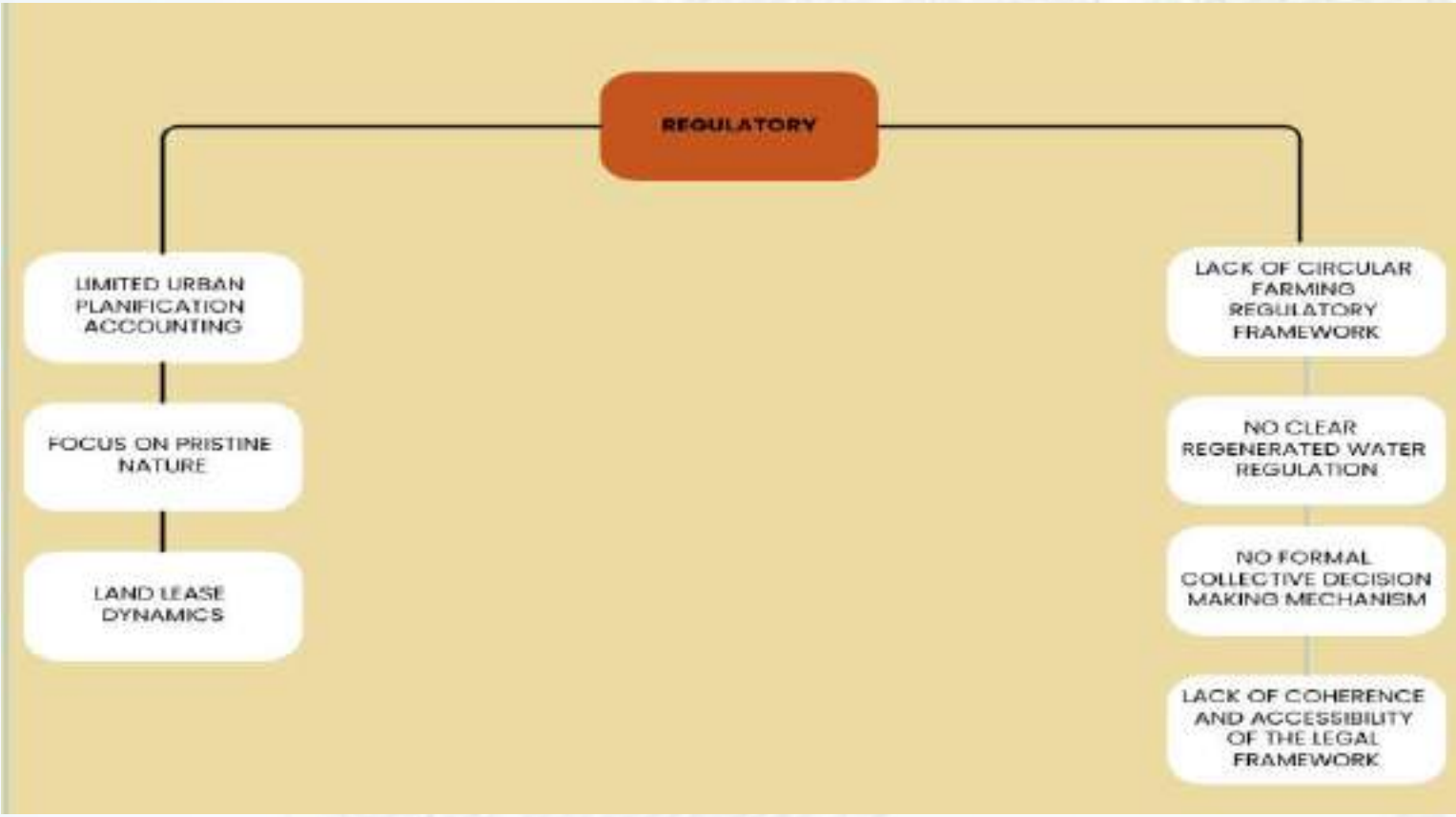

## Economic drivers and obstacles

- Low economic profitability (esp. fruit trees)
- Urban pressure and speculation
- Economic uncertainties hinder investments



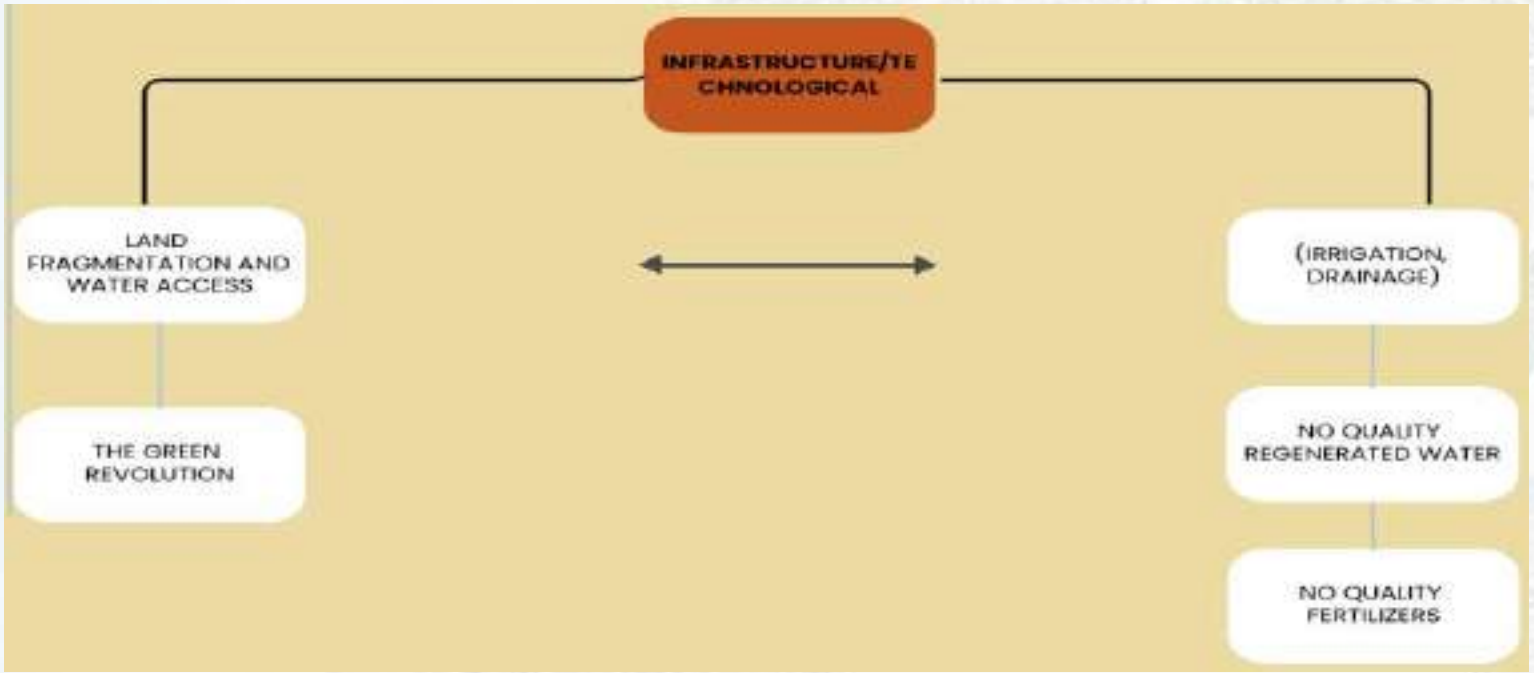

## Socio-political drivers and obstacles

- Lack of political interest / awareness
- Loss of feeling / linkage (intergenerational change)
- Conflict between actors in urban agriculture




## Regulatory drivers and obstacles

- Focus on the protection of pristine nature (forestry law vs. agricultural framework)
- Limited accounting of urban agriculture by urban planning (circular farming, regenerated water)




## Infrastrucutre/technological drivers and obstacles

- Continous technification ("Green Revolution")
- Fragmentation of agricultural land
- Lack of access to water (in upland areas)

## Concluding remark:

The principal drivers of decline and obstacles to urban agriculture are still in place.

Without tackling these, new initiatives will unlikely to unfold their potential.

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Thank you for your attention!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Gara Villalba Mendez

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# The future of urban agriculture from a social and metabolic perspective

## The Edible Cities Network Conference 2023

Gara Villalba

17 de març de 2023

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

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https://urbag.eu/

# Urban Metabolism:
## sum of the technical and socio–economic process- es that occur within the cities, resulting in growth, production of energy, and elimination of waste

Energy
Water
Biomass
Food
Minerals
Imports

Waste, emissions
exports

*Image adapted from https://resourceefficientcities.org/wp-content/uploads/2017/09/Urban-Metabolism-for-Resource-Efficient-Cities.pdf*

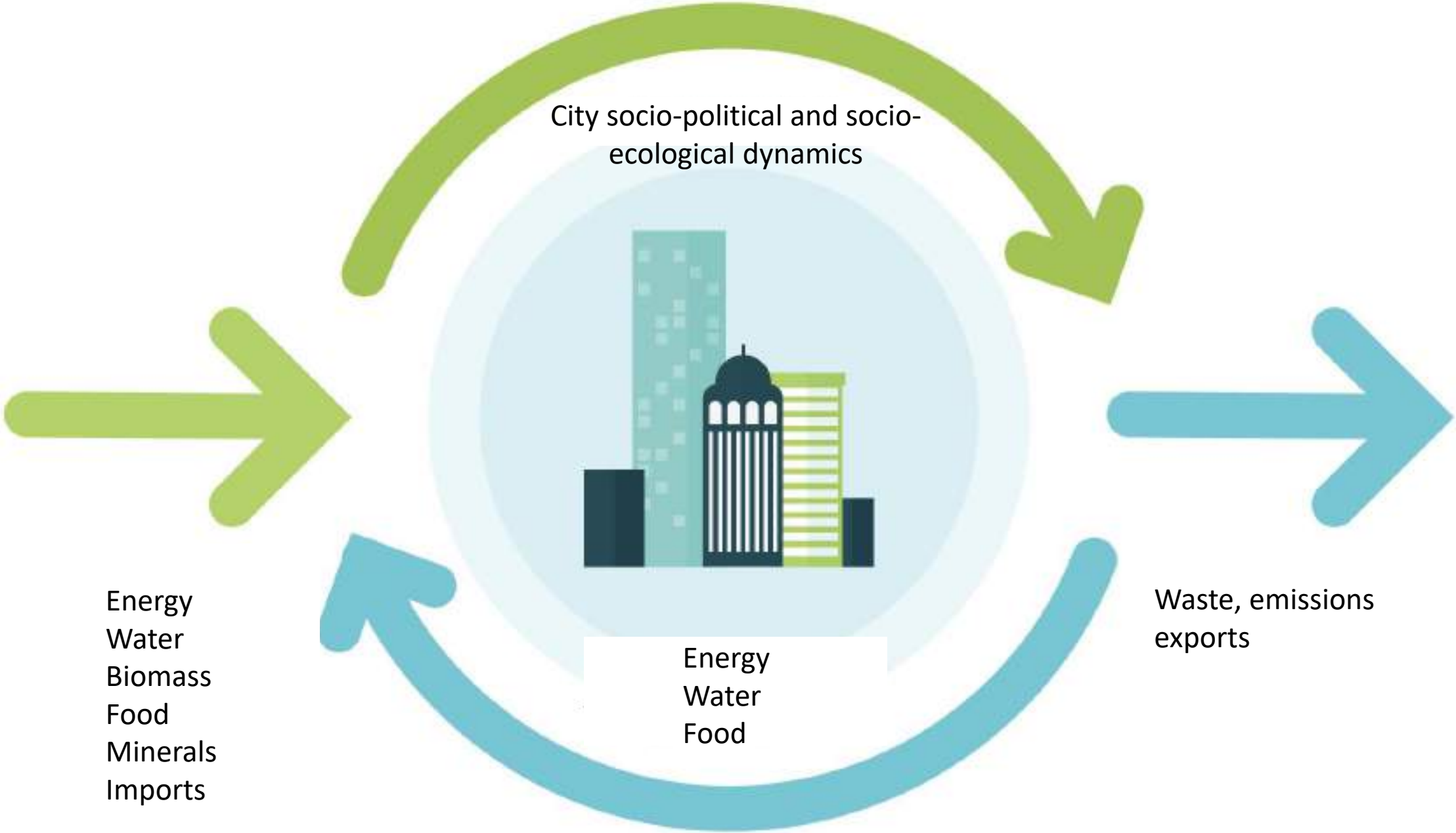
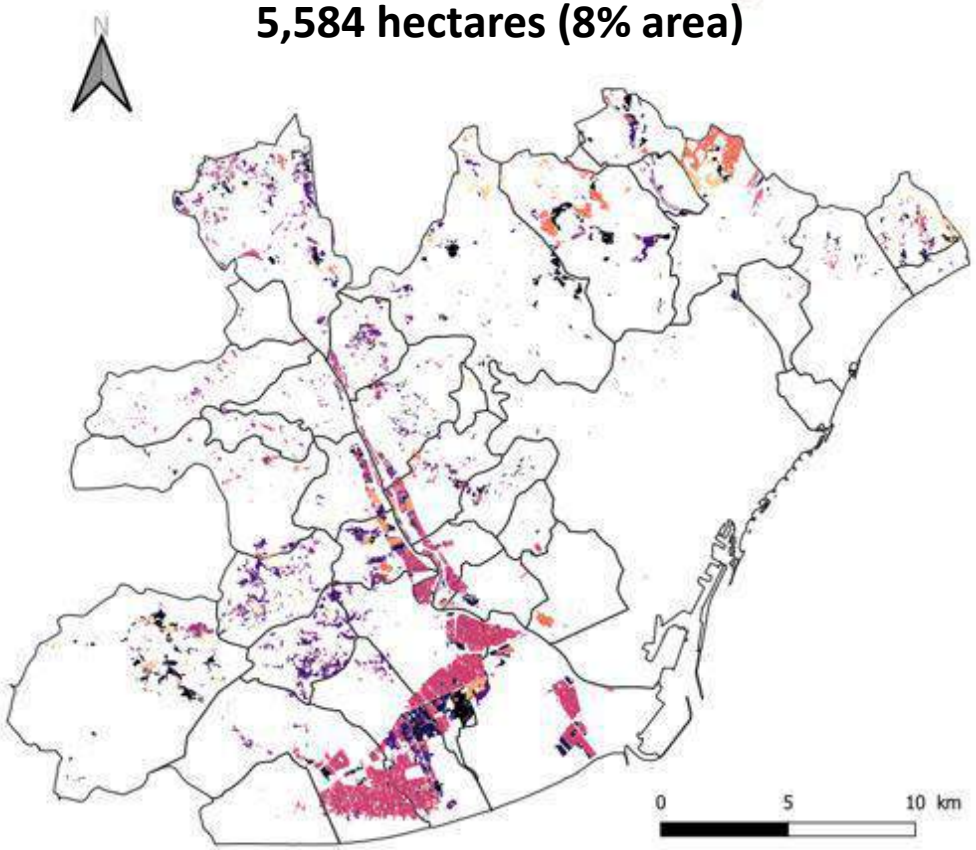



*Image adapted from https://resourceefficientcities.org/wp-content/uploads/2017/09/Urban-Metabolism-for-Resource-Efficient-Cities.pdf*

**Nutrients:**
What are the impacts associated to urban agriculture in terms of fertilizer use? How can circularity of nutrients in urban areas reduce impacts, both direct and indirect?

# Peri-urban agriculture in the AMB

**68,716 tonnes of fruit and vegetables per year (2015)**
**5,584 hectares (8% area)**



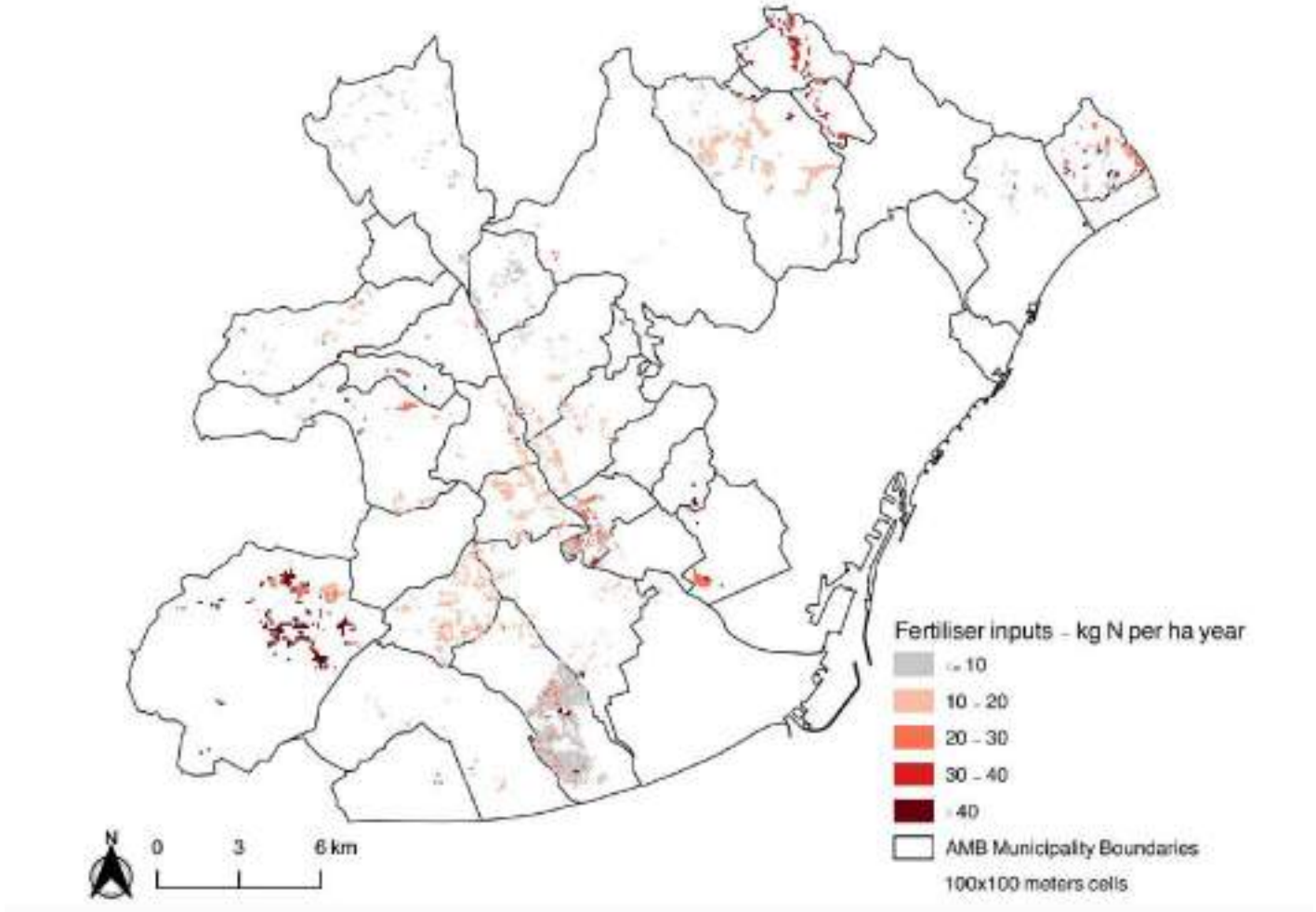

**Categories mapa URBAG**

- Albercoquers
- Alfals
- Altres conreus herbacis
- Altres conreus herbacis abandonats - prats en zones agrícoles
- Altres conreus herbacis abandonats regadiu no regat - prats en zones agrícoles
- Altres conreus herbacis abandonats regadiu no regat - prats en zones agrícoles en bancals
- Altres conreus herbacis en bancals
- Altres conreus herbacis en bancals en regadiu
- Altres conreus herbacis en regadiu
- Altres fruiters
- Ametllers
- Blat dur
- Blat tou
- Caqui
- Carabassa
- Carxofa
- Cireres
- Civada
- Codony
- Cogombre
- Colza
- Conreus d'horta sota plàstic
- Conreus en transformació
- Faves i favons
- Figuera
- Fruiters no cítrics
- Fruiters no cítrics abandonats - prats en zones agrícoles
- Fruiters no cítrics abandonats - prats en zones agrícoles en bancals
- Fruiters no cítrics abandonats regadiu no regat - prats en zones agrícoles
- Fruiters no cítrics en bancals
- Fruiters no cítrics en bancals en regadiu
- Fruiters no cítrics en regadiu
- Fruiters varis
- Garroferars
- Garroferars abandonats - prats en zones agrícoles
- Garroferars en bancals
- Guaret no sie/sup. lliure sembra
- Guaret sie/sup. lliure sembra
- Hivernades
- Horta
- Horta familiar
- Mandariner
- Nectarins
- Nesprers
- Oliverars
- Oliverars abandonats - prats en zones agrícoles
- Oliverars en bancals
- Oliverars en regadiu
- Oliveres
- Ordi
- Pereres
- Pesols
- Pomeres
- Presseguers
- Presseguers/Nectarins
- Pruneres
- Ray-grass
- Rompudes agrícoles
- Sorgo
- Taronger
- Tomaquet
- Trepadella
- Triticale
- Veca i civada
- Vinyes
- Vinyes
- Vinyes abandonades - prats en zones agrícoles
- Vinyes en bancals
- Vivers agrícoles
- Municipis AMB

*Location of peri-urban agriculture in the Metropolitan Area of Barcelona (AMB) and different land uses according to the URBAG map. Taken from: Mendoza Beltran et al., (2022)*

# Nutrients: peri-urban agriculture

**Use of fertilizers 963 tonnes of N and 152 tonnes of P per year (2015)**




-mostly from mineral fertilizer

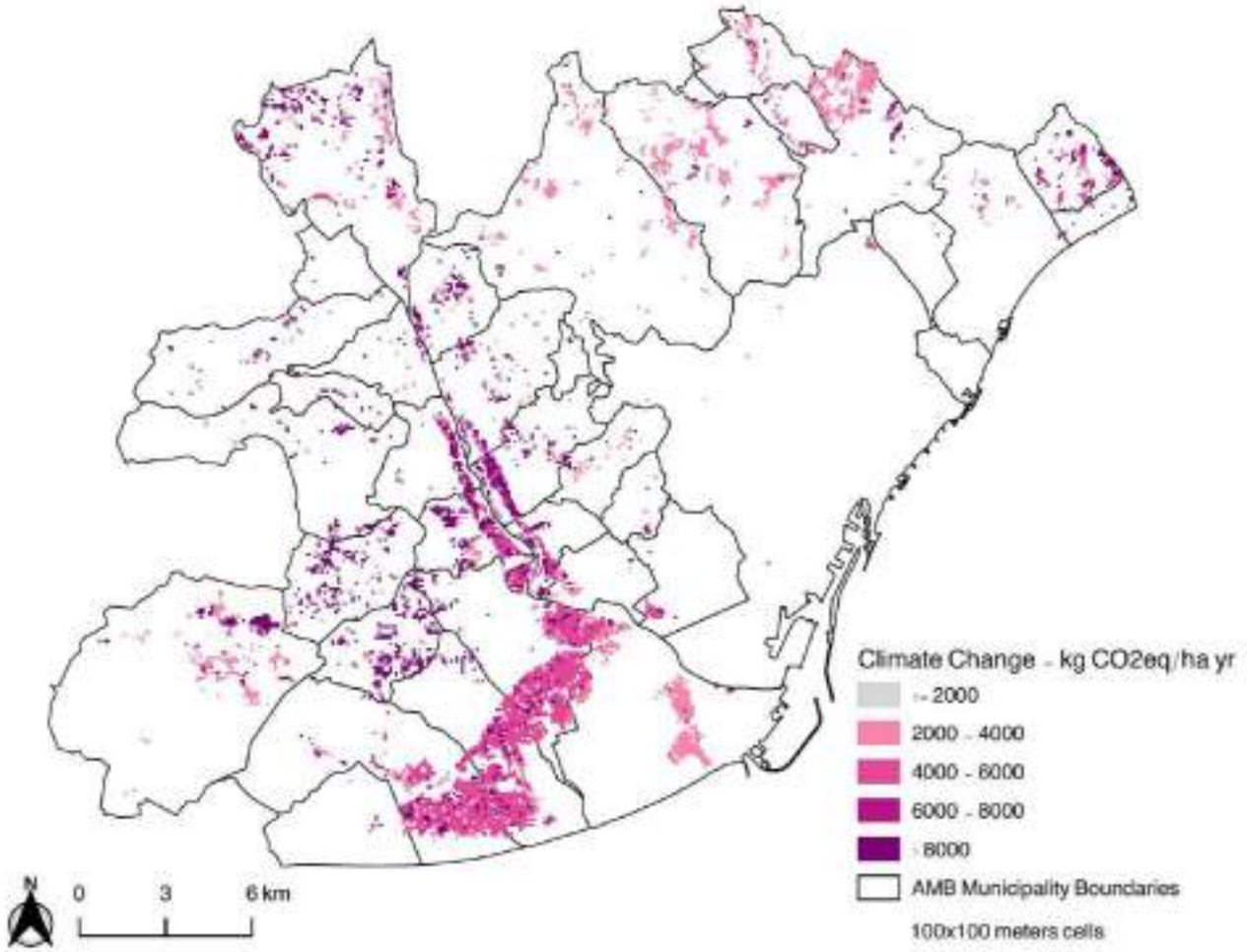
-less than 7% of fertilizer supply comes from compost

-there is no recovery of nutrients from other sources

*Location of peri-urban agriculture in the Metropolitan Area of Barcelona (AMB) and different land uses according to the URBAG map. Taken from: Mendoza Beltran et al., (2022)*

# Nutrients: peri-urban agriculture

**Climate change impact: 12,120 tonnes of CO2e per year (2015)**




-65% from production of mineral fertilizer

-35% direct emissions due to fertilizer application on the soil

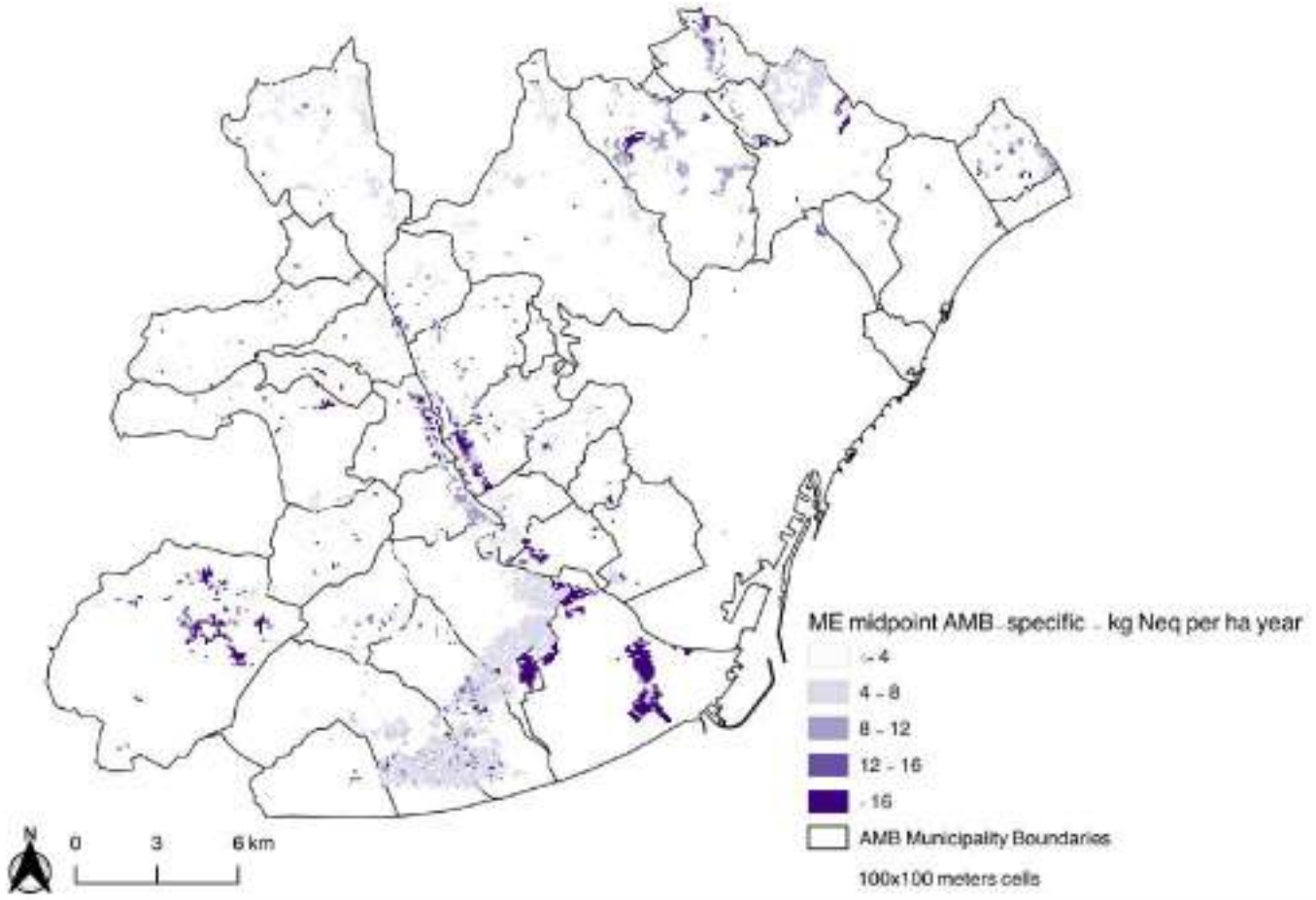
-compost could reduce agriculture carbon footprint by 65% if all organic waste is composted (substituting mineral fertilizer)

-Estruvite from WWTPs: we have 5 times de P necessary for the agriculture of the AMB. Could reduce by half the CO2e/kg P attributed to production of P.

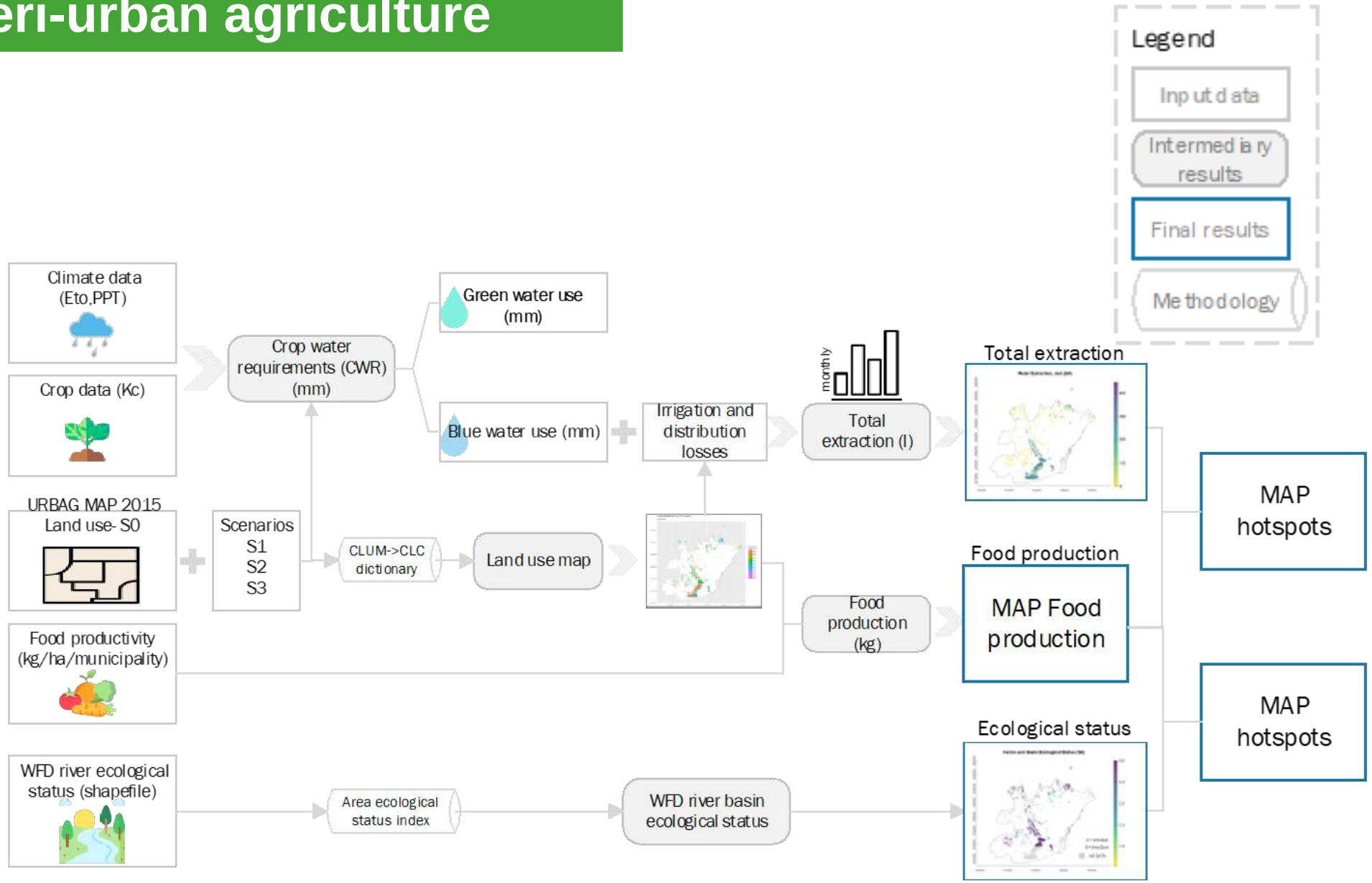
*Location of peri-urban agriculture in the Metropolitan Area of Barcelona (AMB) and different land uses according to the URBAG map. Taken from: Mendoza Beltran et al., (2022)*

# Nutrients: peri-urban agriculture

**Eutrophication**
**Agriculture emits 48.9 tonnes of N equivalents to the sea yearly (2015)**

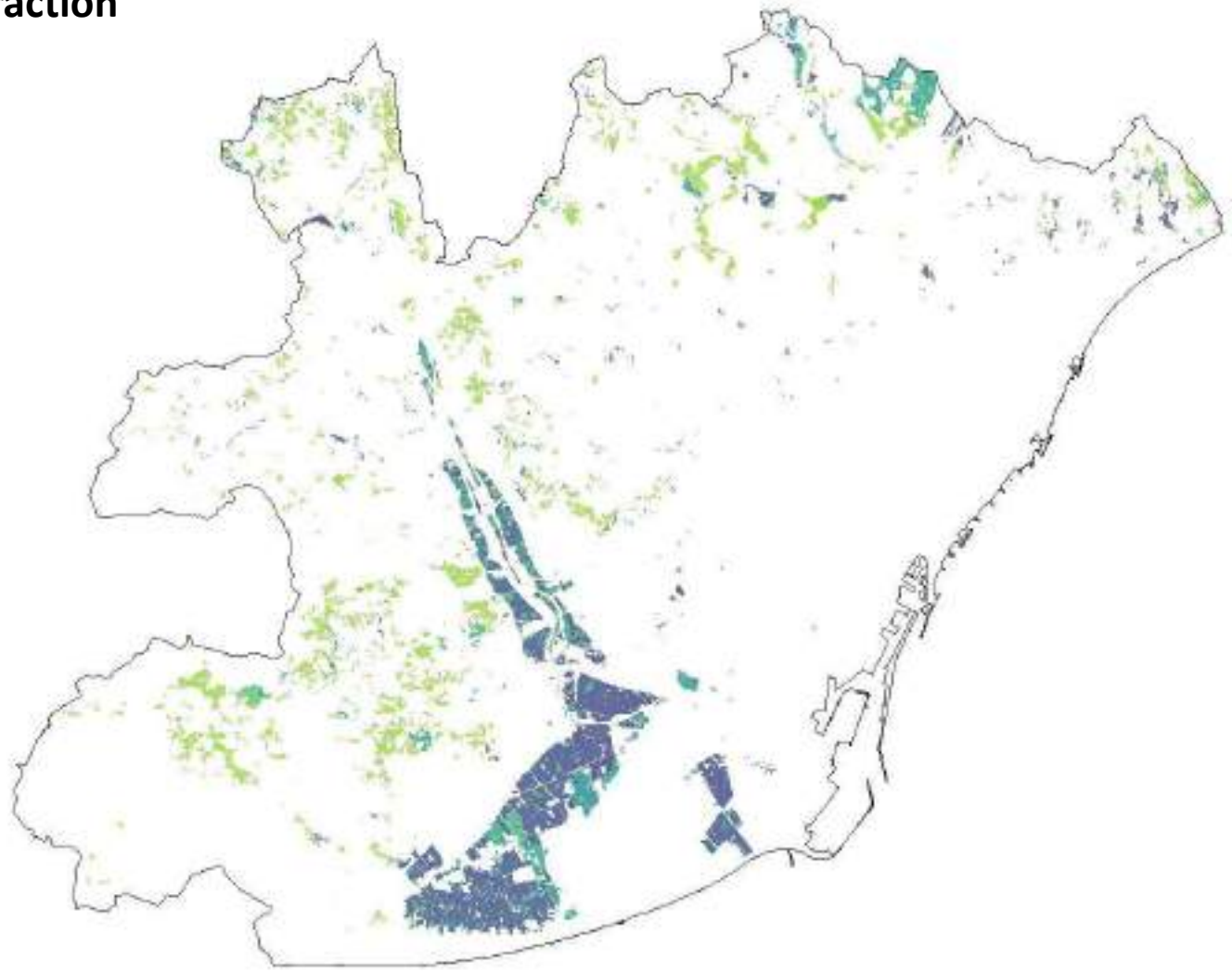


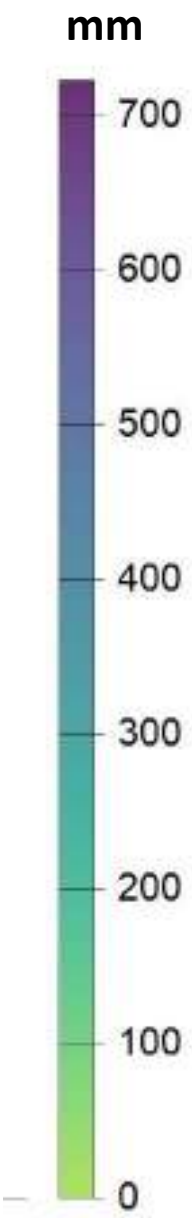
# Water: peri-urban agriculture



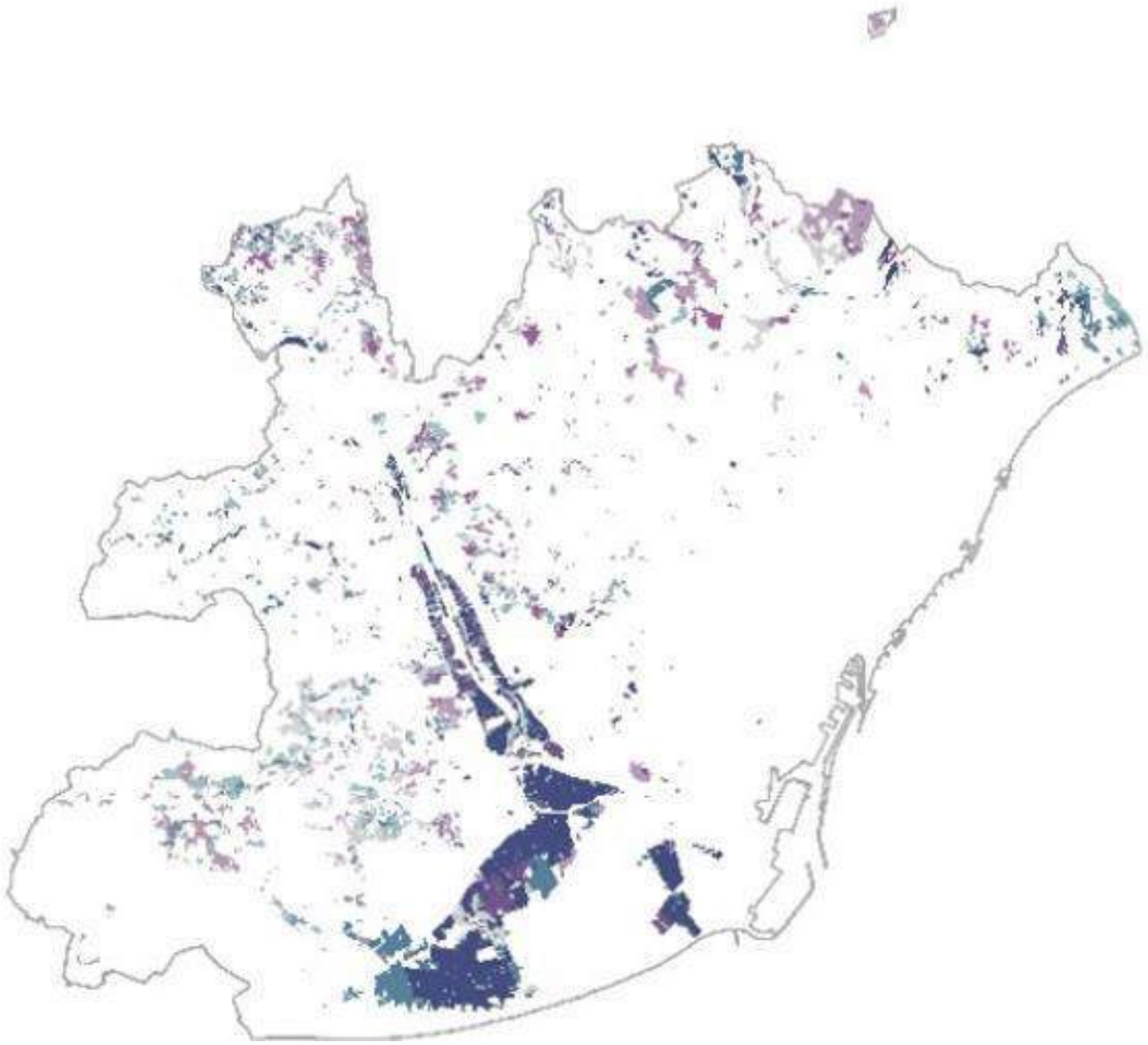
# Water: peri-urban agriculture

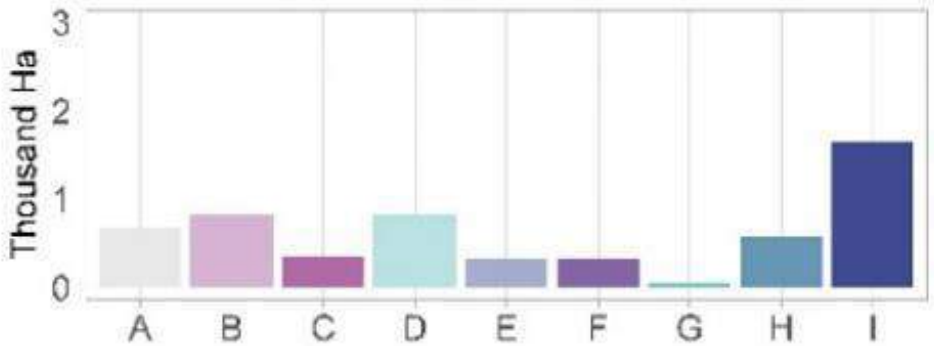
**15 $hm^3$ irrigation**
**25.7 $hm^3$ extraction**

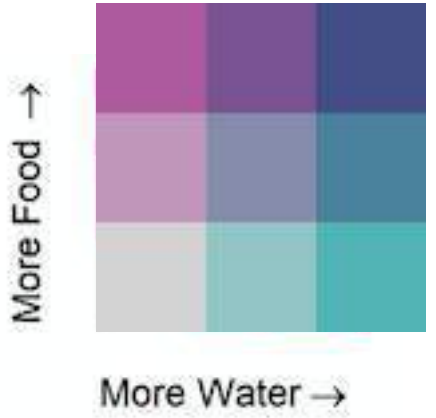




# Water-Food nexus

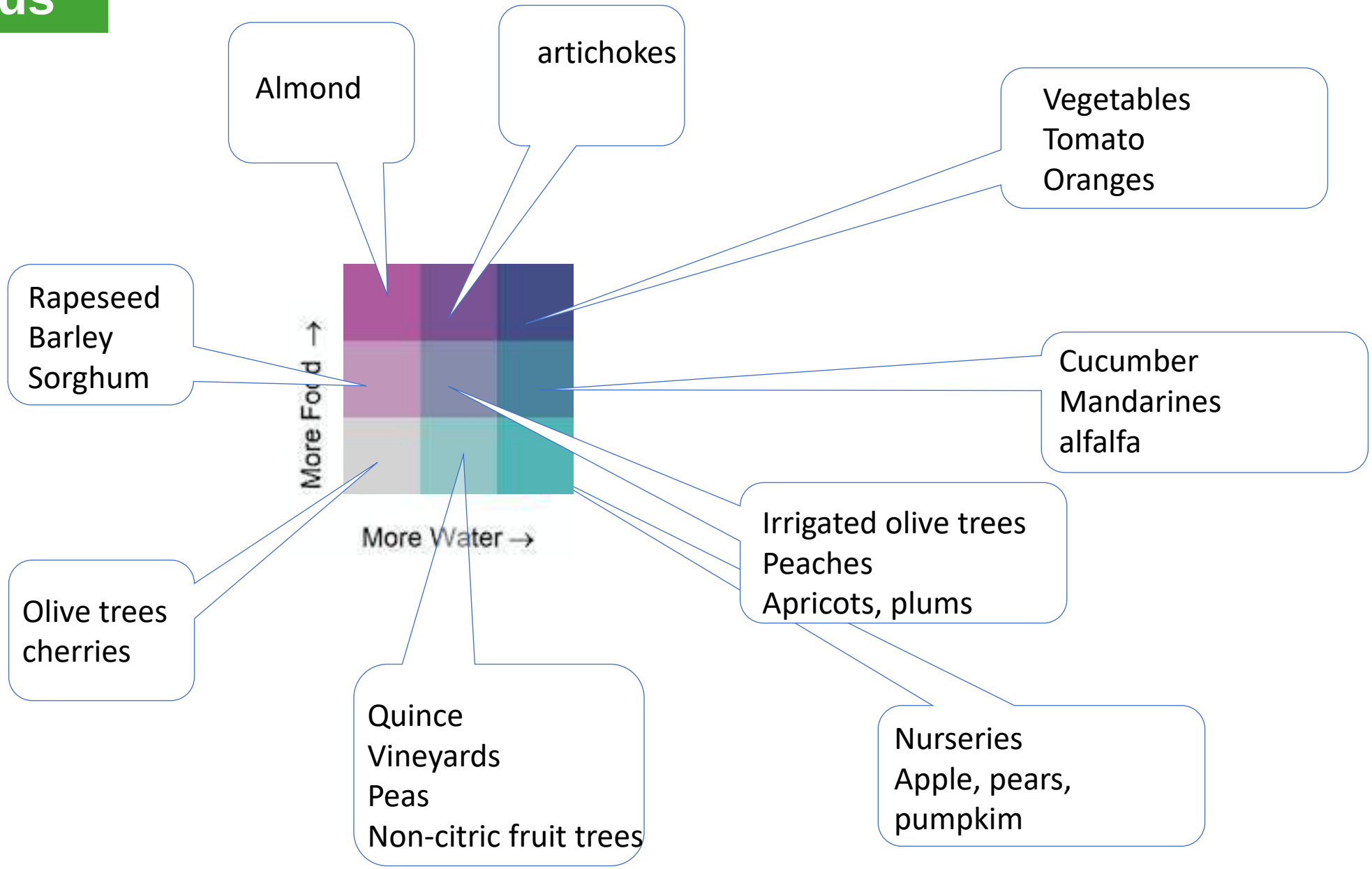





*Manuscript: "A georeferenced sustainability water metabolism assessment for managing trade-offs at the nexus between water, peri-urban agriculture, and the environment" in progress.*

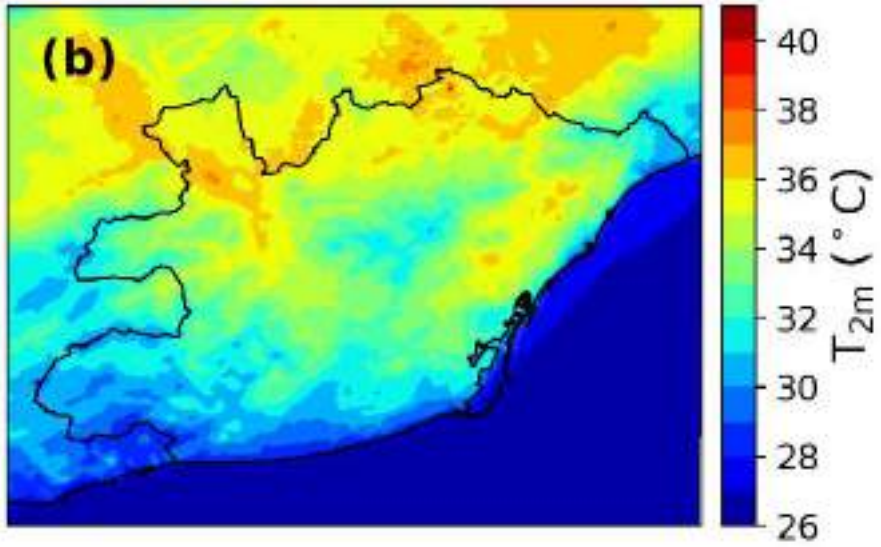
# Water-Food nexus




*Manuscript: "A georeferenced sustainability water metabolism assessment for managing trade-offs at the nexus between water, peri-urban agriculture, and the environment" in progress.*

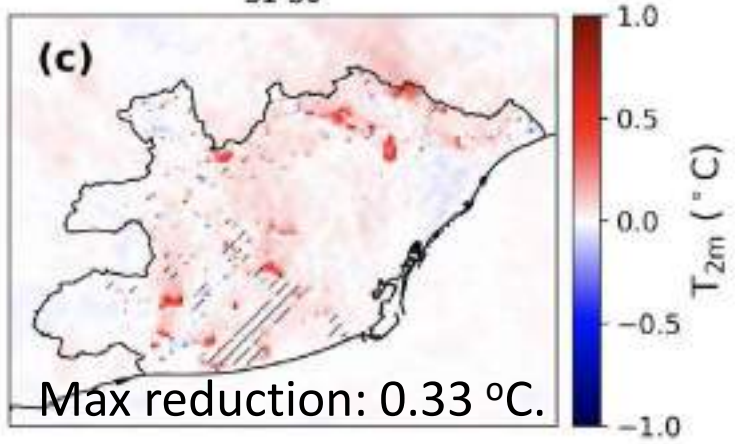
# Energy-water-agriculture

25 juny - 25 july 2015Mitjana hourly average between 13 - 16h

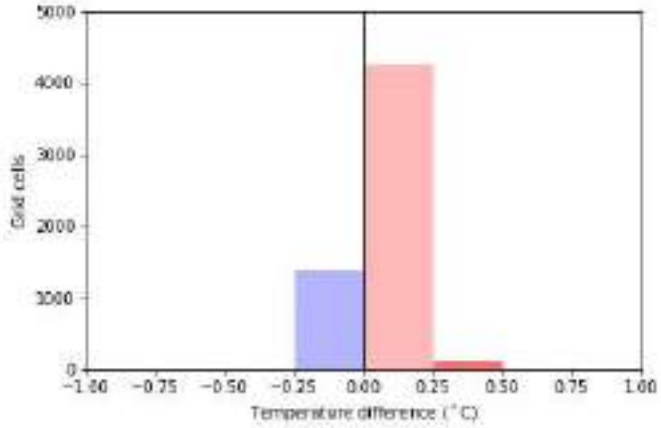


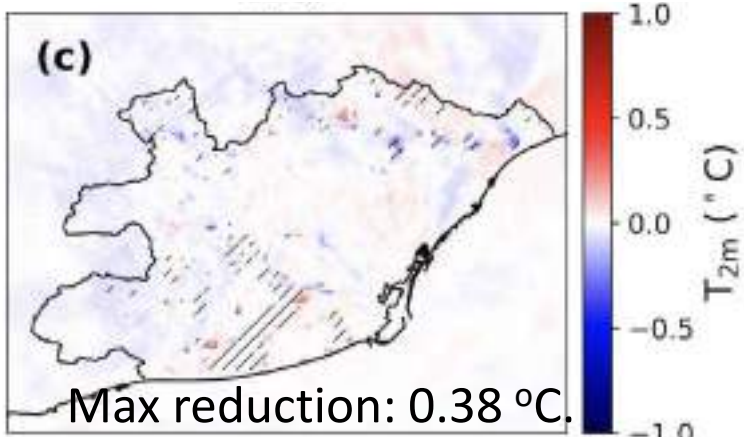

| | Land-cover | | | | |
|---|---|---|---|---|---|
| | Urban* | Forest** | Agriculture | Pastures | Other*** |
| S0. | 45% | 42% | 8% | 3% | 2% |
| S1. | 52% | 38% | 6% | 2% | 2% |
| S2. | 46% | 38% | 12% | 2% | 2% |
| S3. | 45% | 32% | 20% | 2% | 2% |

S1-S0

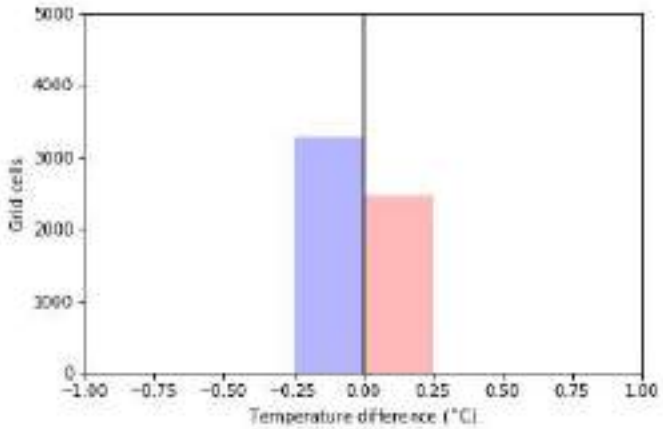



Max reduction: 0.33 °C.

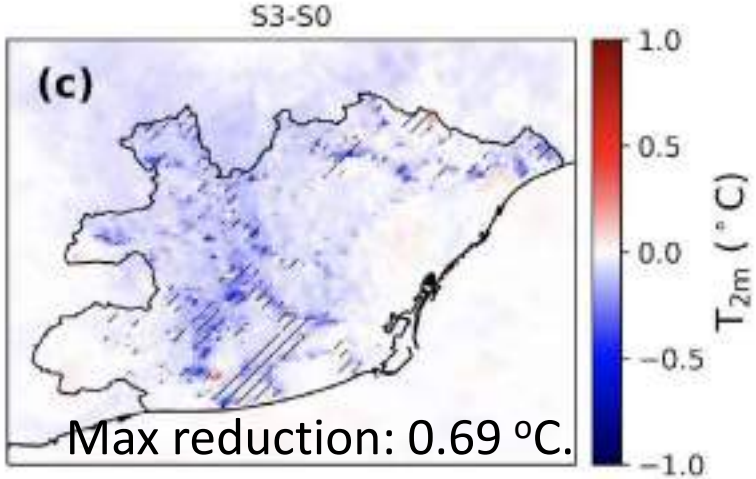


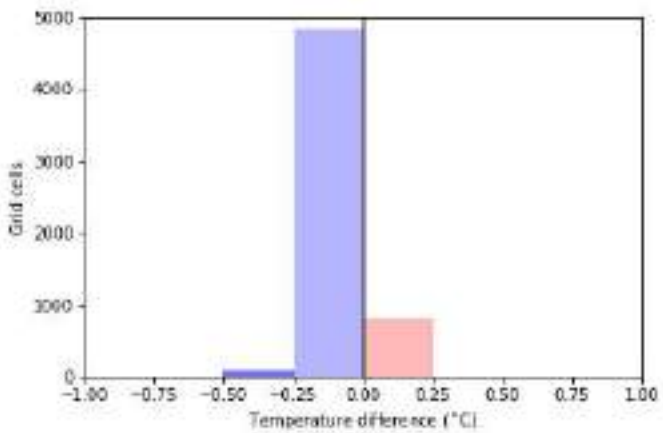

Max reduction: 0.38 °C.




S3-S0




Max reduction: 0.69 °C.



URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Thank you for your attention!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# Potential of nutrient recovery from organic municipal solid waste: Application to peri-urban agriculture of the AMB

## The Edible Cities Network Conference 2023

Juan Arosemena

March 17th, 2023

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

Juandavid.Arosemena@uab.cat
https://urbag.eu/

# Context

Urban growth = Cities need to tackle:

Food demand & municipal solid waste generation

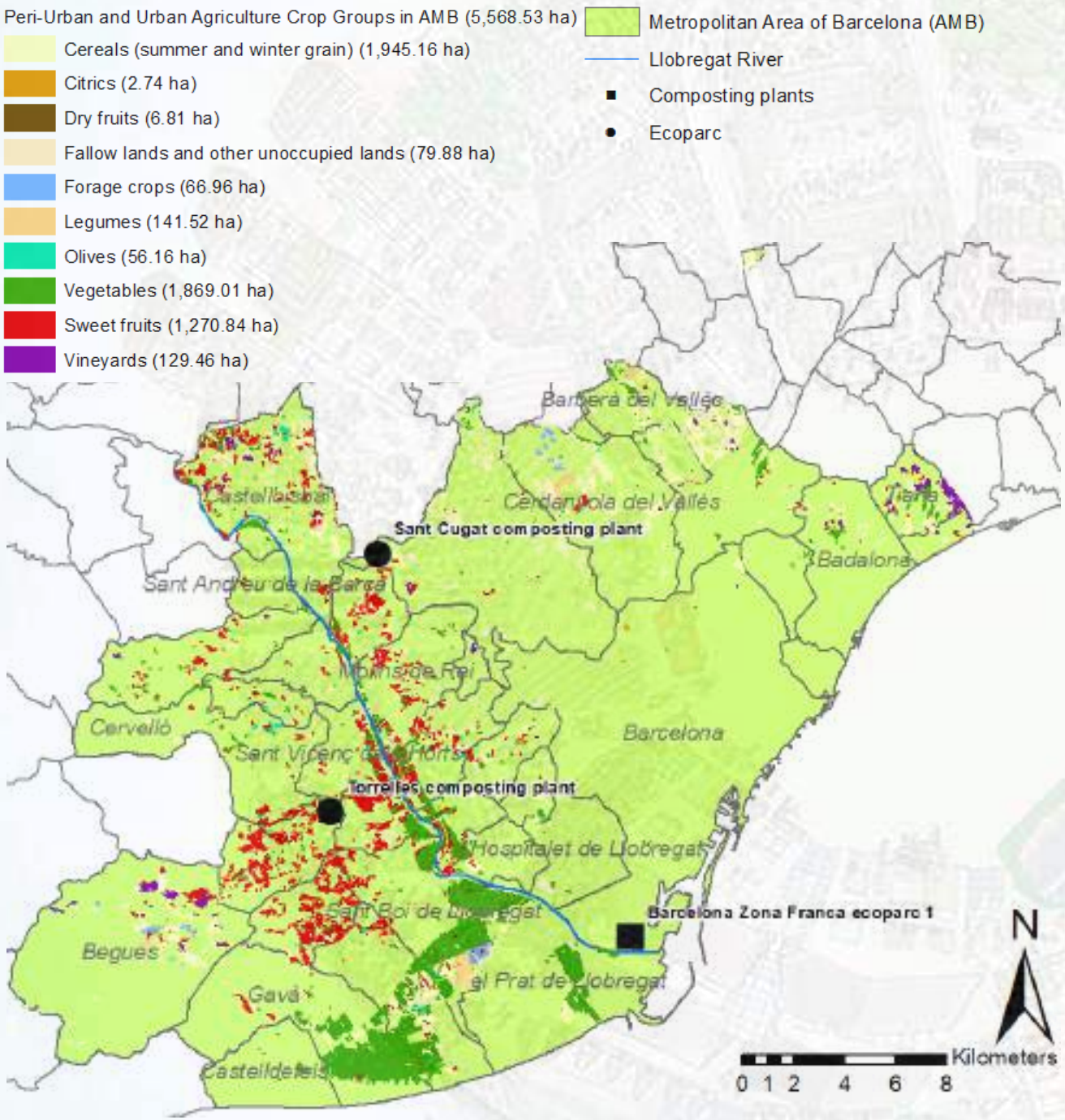
**Urban agriculture**

- Local resources → Urban crop production
- Organic solid waste → Compost fertilizer
- Circular strategies → Nutrient recovery

# Research aim

- Potential of OMSW compost to supply nutrients (N, P and K) demanded by UA in AMB?

- Environmental benefits of replacing mineral fertilizer while minimizing OMSW in AMB?




# Materials & methods

## NPK demand?

✓ Agricultural spatial data

## Compost NPK supply?

✓ Centralized compost production reports

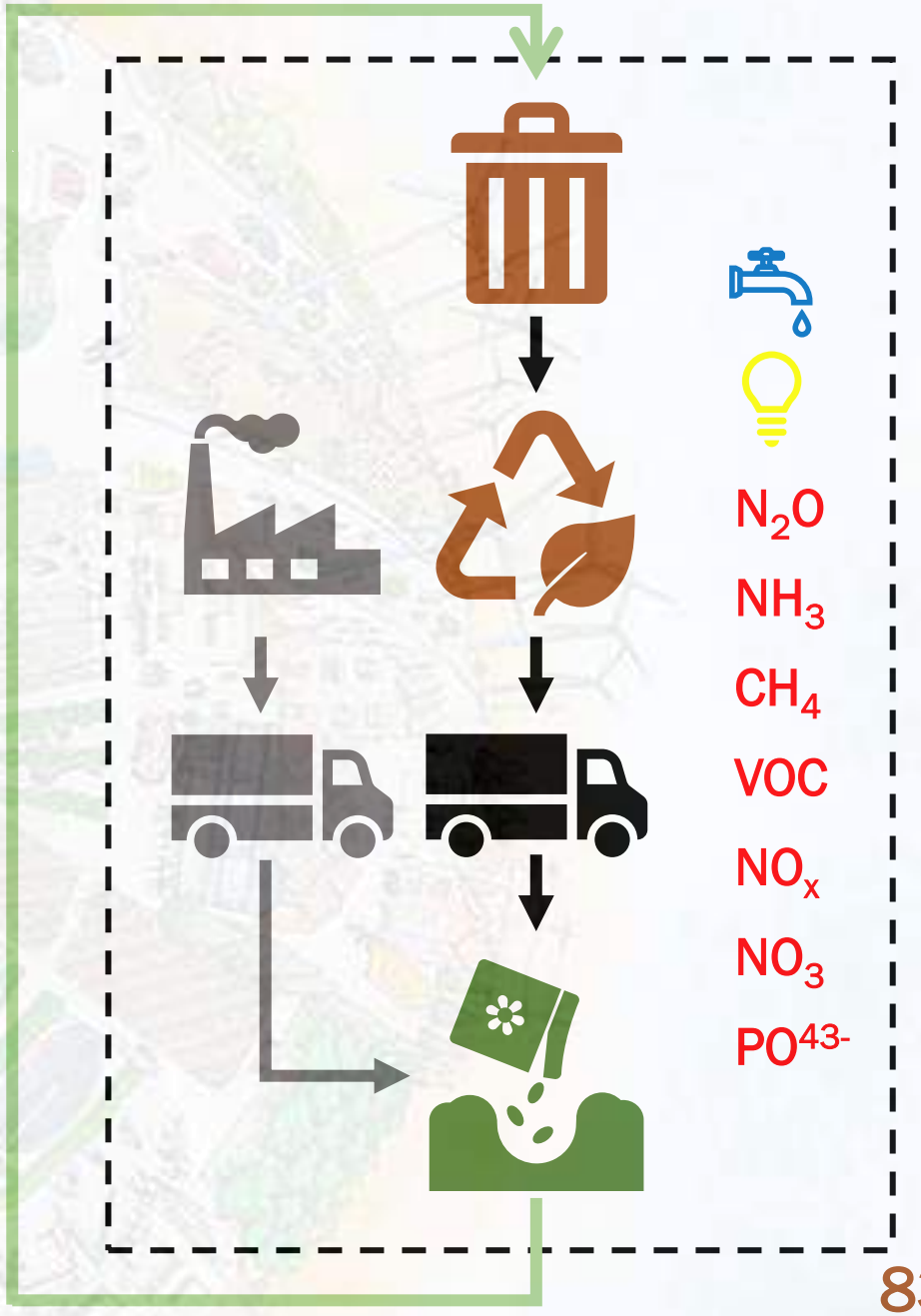
# Materials & methods

## Scenarios?

1. Mineral fertilizer only
2. + Compost supply (current)
3. + Compost supply ( PREMET 25 )

## Impacts/benefits?

✓ Life Cycle Assessment (LCA)



# Results – Compost NPK supply potential

The AMB needs a **yearly total of 1,519 tonnes of NPK**

- N - 769 t
- P - 158 t
- K - 592 t

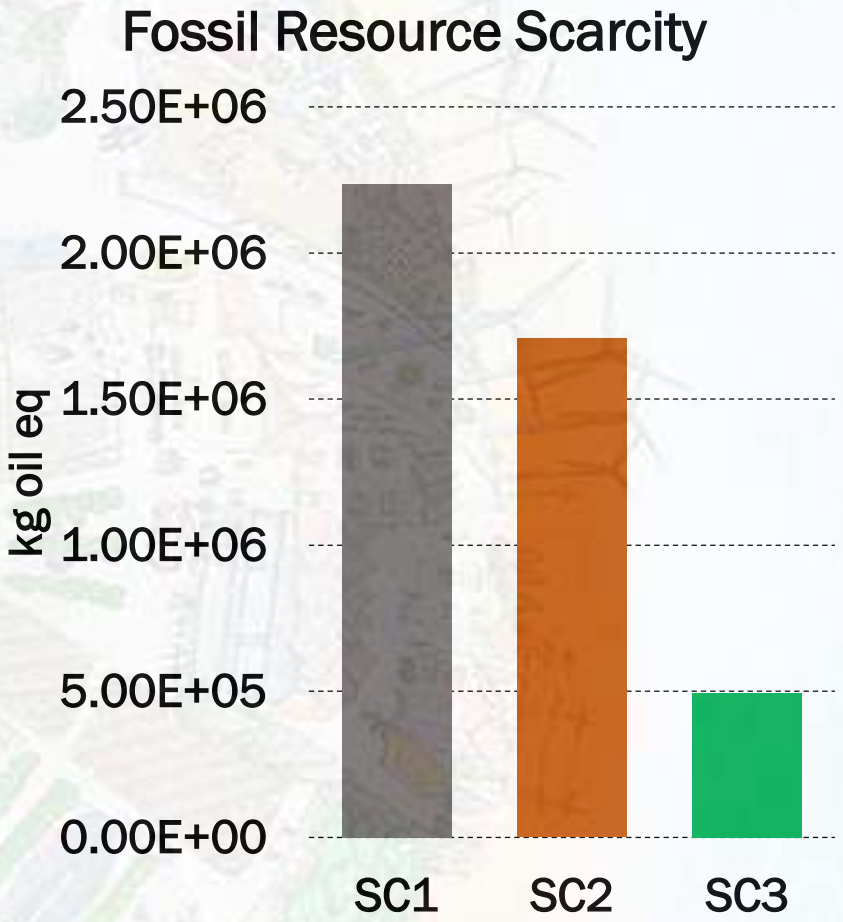
for 68,800 tonnes of fresh produce . . .

can potentially supply

- **7%** of the total NPK demand with current compost system
- and **21%** if compost production is increased

# Results – Environmental assessment of scenarios

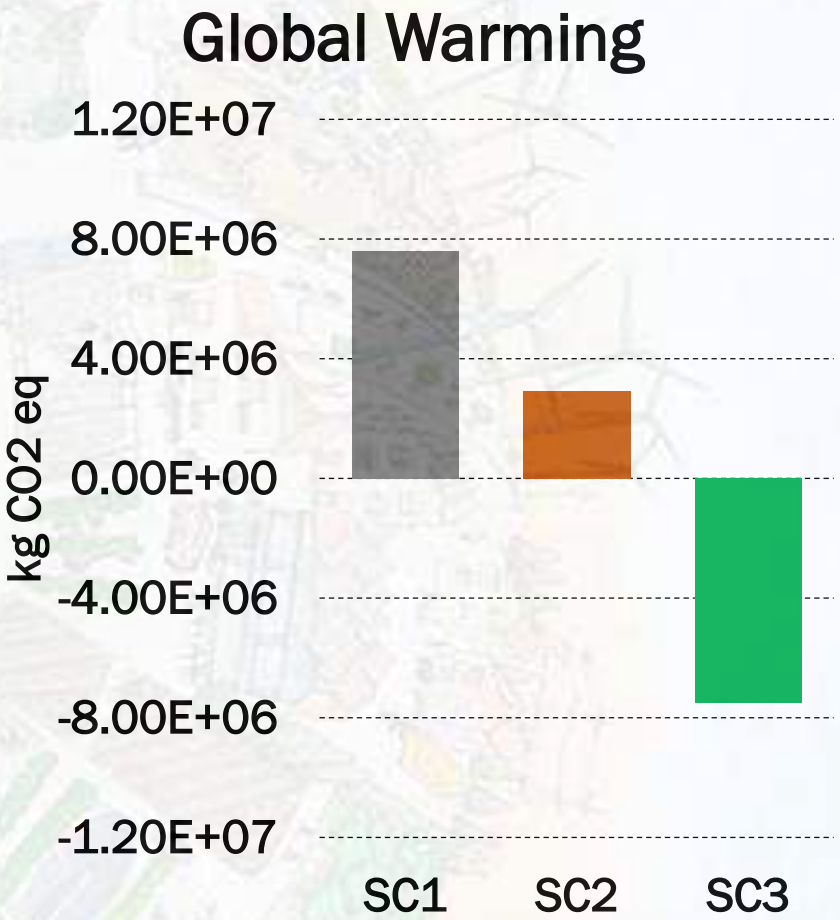
Compost scenarios outperformed the mineral fertilizer only scenario with **impact decreases of up to 78%** (Fossil Resource Scarcity) . . .




SC1 = Mineral fertilizer
SC2 = + Compost supply (current)
SC3 = + Compost supply (PREMET25)

# Results – Environmental assessment of scenarios

. . . and **environmental savings equal to 9% of the total net carbon footprint** of the MSW system in the AMB




SC1 = Mineral fertilizer
SC2 = + Compost supply (current)
SC3 = + Compost supply (PREMET25)

# What's next?

- ✓ Policy making based on a **life cycle perspective**
- ✓ Exploit city's benefits as **nutrients circularity** and synergies between UA and OMSW

**Limitations or opportunities?**

- Compost end-use, regulations (use of organic fertilizers), **soil regeneration**

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Thank you for your attention!

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https://urbag.eu/

# Q&A

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# Peri-urban agriculture in the Metropolitan Area of Barcelona

*Understanding its impacts through a through a vulnerability lens*

**The Edible Cities Network Conference 2023**

March 17th, 2023

David A. Camacho
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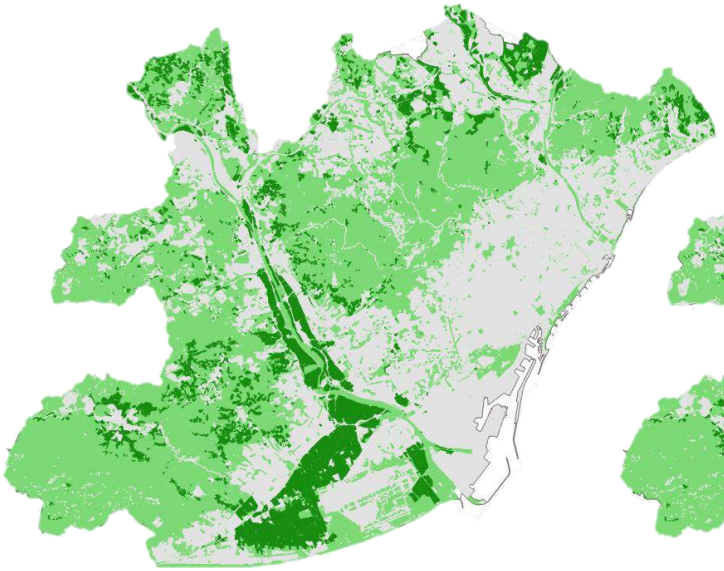
URBAG Integrated System Analysis of Urban Vegetation and Agriculture

# AMB scenario description

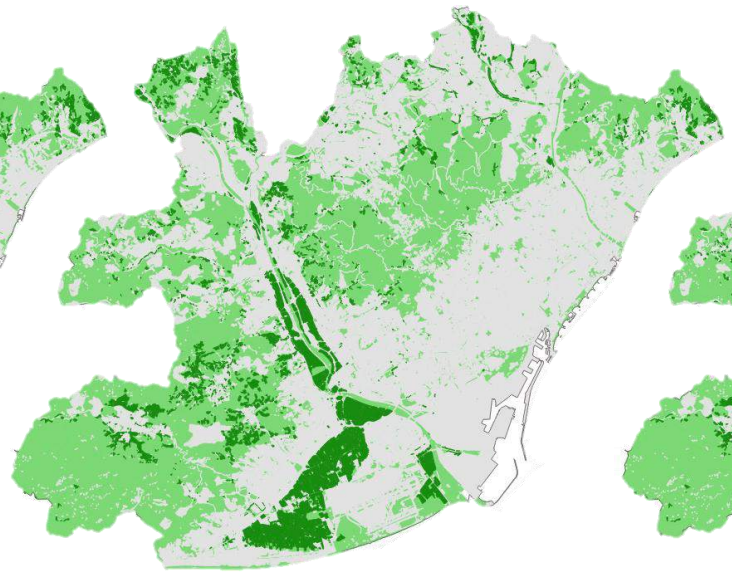
Agriculture
Other green
Urban

## S0. Current



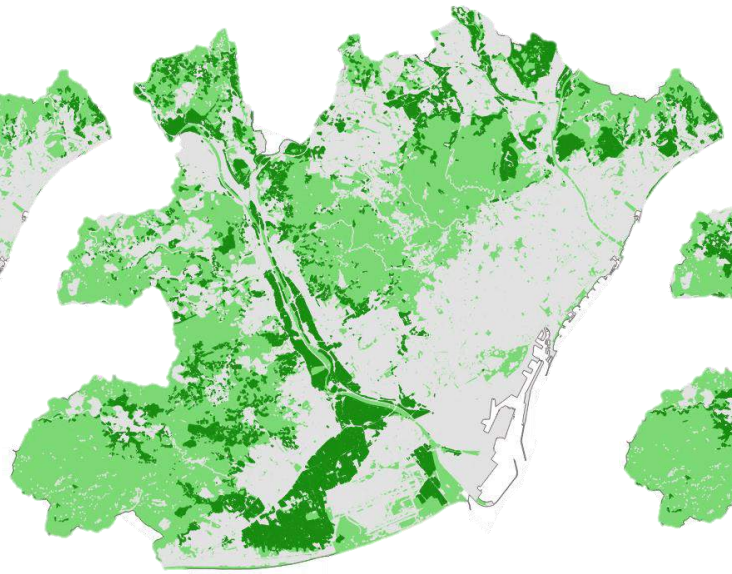
| | |
|---|---|
| Agriculture | 8% |
| Other green | 45% |
| Urban | 47% |

## S1. Trending



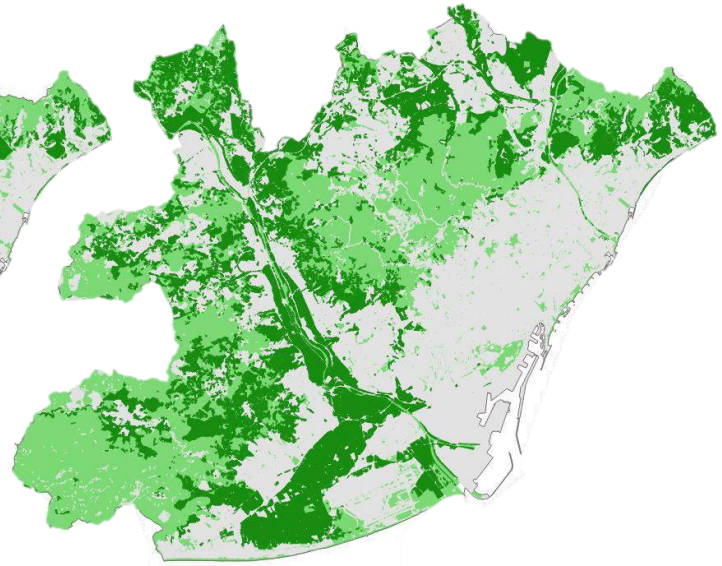
| | |
|---|---|
| Agriculture | 6% |
| Other green | 40% |
| Urban | 54% |

## S2. Alternative



| | |
|---|---|
| Agriculture | 12% |
| Other green | 40% |
| Urban | 48% |

## S3. Potential



| | |
|---|---|
| Agriculture | 20% |
| Other green | 34% |
| Urban | 46% |

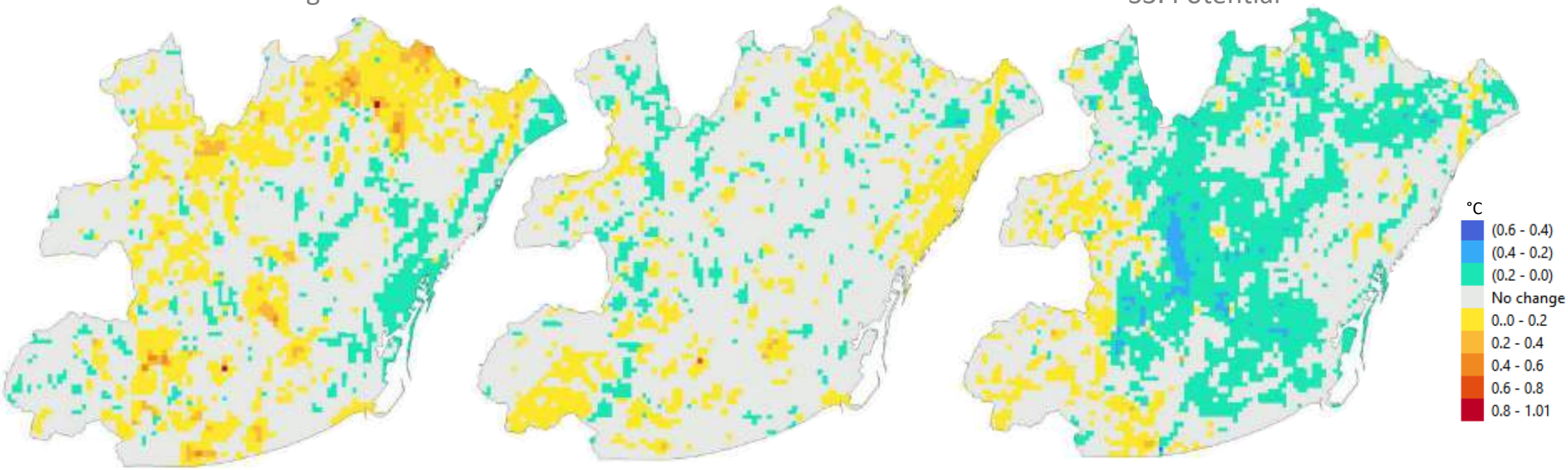
# Heat conditions and exposure

*Current state VS possible future scenarios*

S1. Trending

S2. Alternative

S3. Potential




+ 0.02 °C

S0: 29.48 °C; S1: 29.5 °C

+ 0.01 °C

S0: 29.48 °C; S1: 29.48 °C

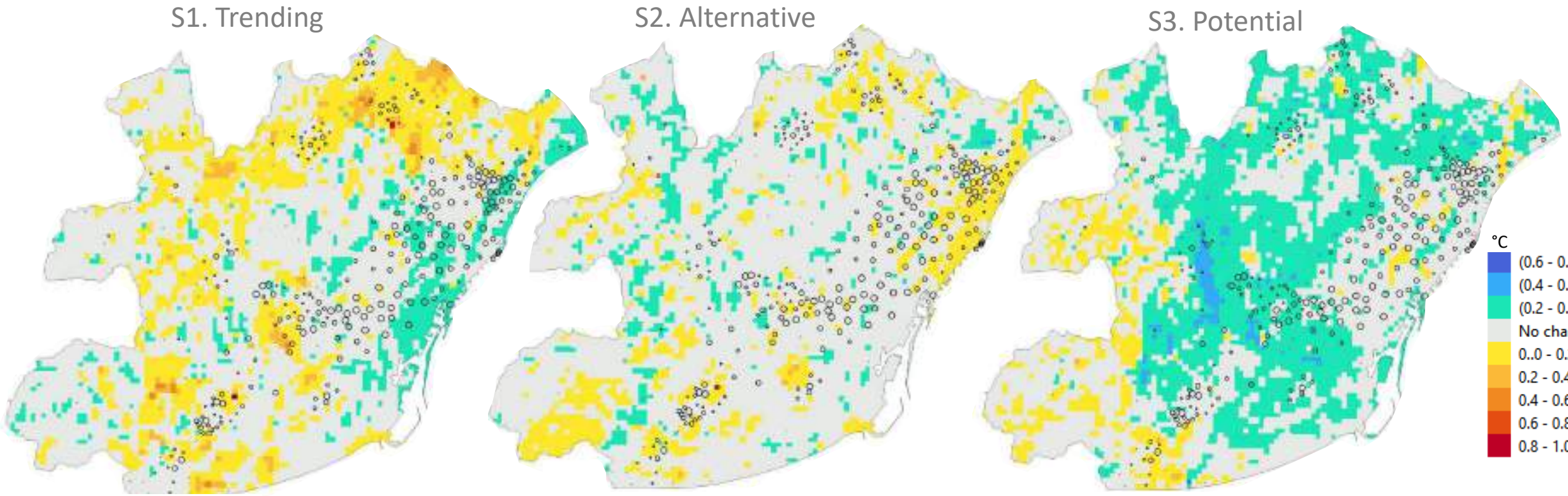
- 0.04 °C

S0: 29.48 °C; S1: 29.44 °C

Overall change in average temperature during heatwave (midday & night)

# Heat conditions and exposure

*Current state VS possible future scenarios*




+ 0.02 °C

S0: 29.48 °C; S1: 29.5 °C

+ 0.01 °C

S0: 29.48 °C; S1: 29.48 °C

- 0.04 °C

S0: 29.48 °C; S1: 29.44 °C

Change in average daily temperature (midday & night)

Total pop density (h/km2)

- 95 - 4,902
- 4,902 - 14,297
- 14,297 - 25,401
- 25,401 - 41,384
- 41,384 - 84,498

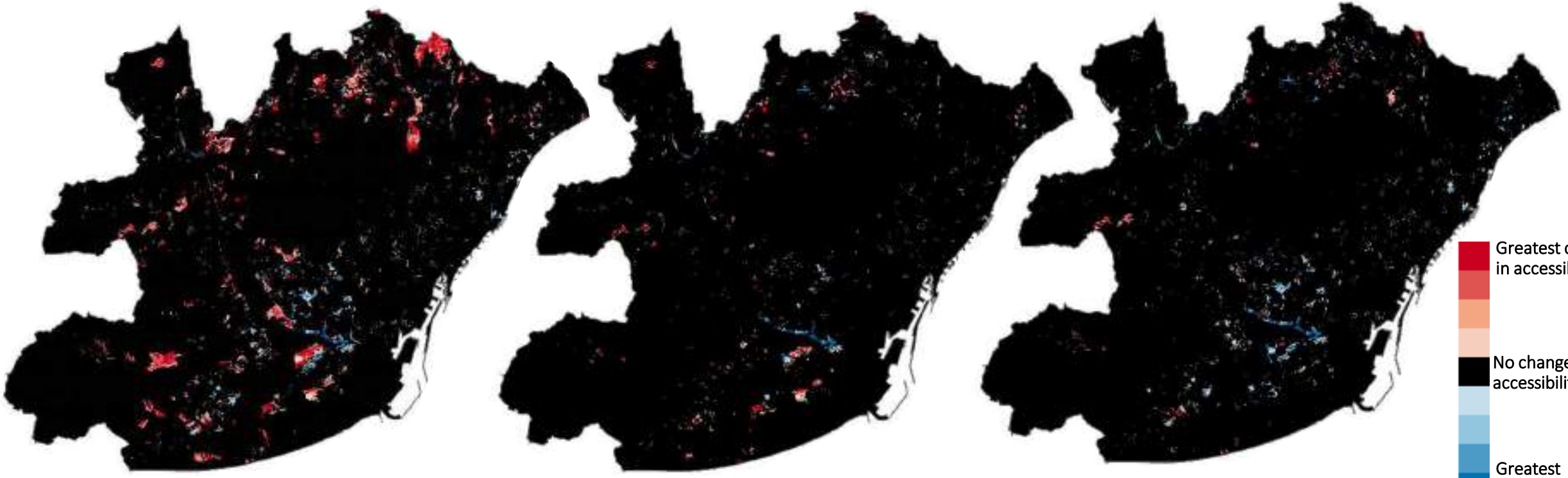
# Spaces for cultural and recreational experiences

*Current state VS possible future scenarios*

S1. Trending

S2. Alternative

S3. Potential




- 1.60%

S0: 91.53%; S1: 89.92%

- 0.15%

S0: 91.53%; S1: 91.38%

+ 0.18%

S0: 91.53%; S1: 91.70%

Change in % of areas with accessibility to green spaces

# Spaces for cultural and recreational experiences

*Current state VS possible future scenarios*

S1. Trending

S2. Alternative

S3. Potential


- 1.60%

S0: 91.53%; S1: 89.92%

- 0.15%

S0: 91.53%; S1: 91.38%

+ 0.18%

S0: 91.53%; S1: 91.70%

Change in % of areas with accessibility to green spaces

Total pop density (h/km2)

- 95 - 4,902
- 4,902 - 14,297
- 14,297 - 25,401
- 25,401 - 41,384
- 41,384 - 84,498

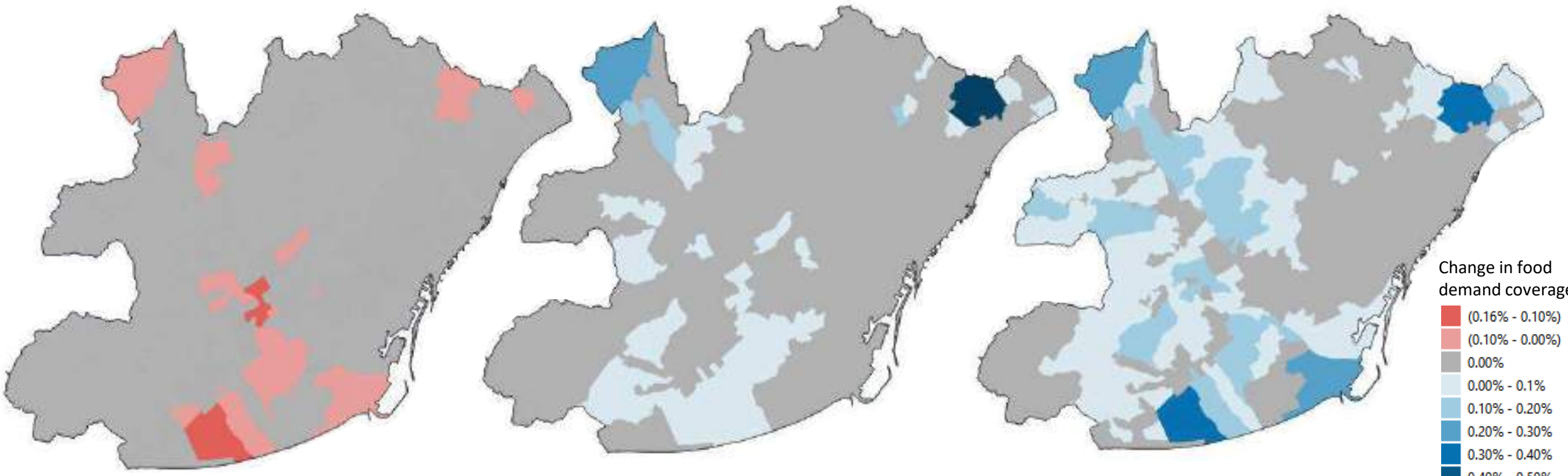
# Food self-sufficiency (FOOD)

*Current state VS possible future scenarios*

S1. Trending

S2. Alternative

S3. Potential




- 0.9%

S0: 7.1%.; S1: 6.2%

+ 1.9%

S0: 7.1%.; S1: 8.9%

+ 5.8%

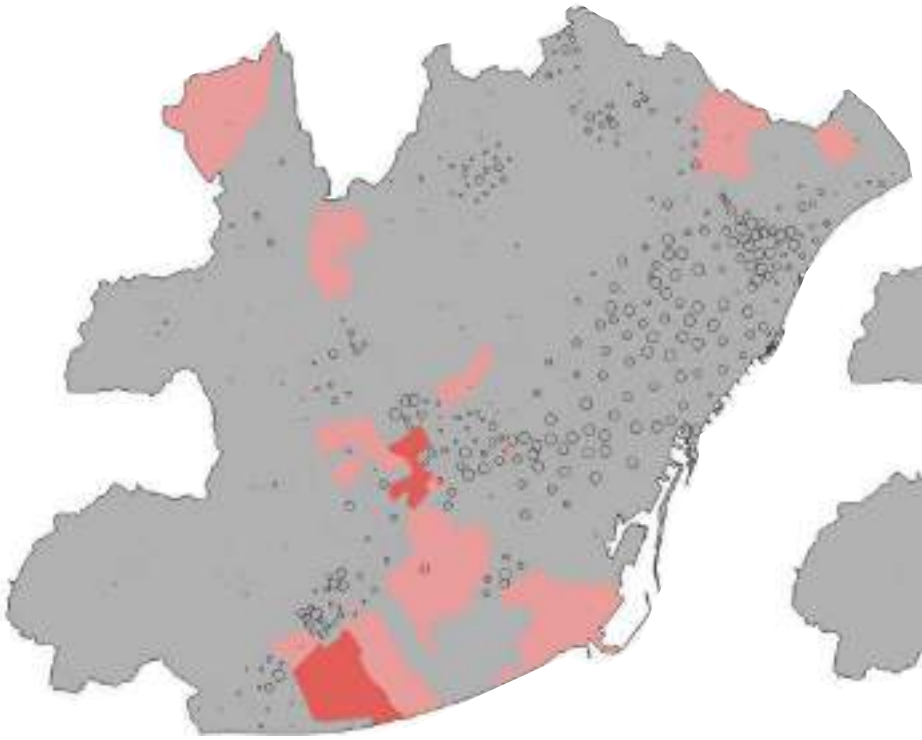
S0: 7.1%.; S3: 12.9%

Overall change in coverage of food demand of fruits and vegetables by local production(%)

# Food self-sufficiency (FOOD)

*Current state VS possible future scenarios*

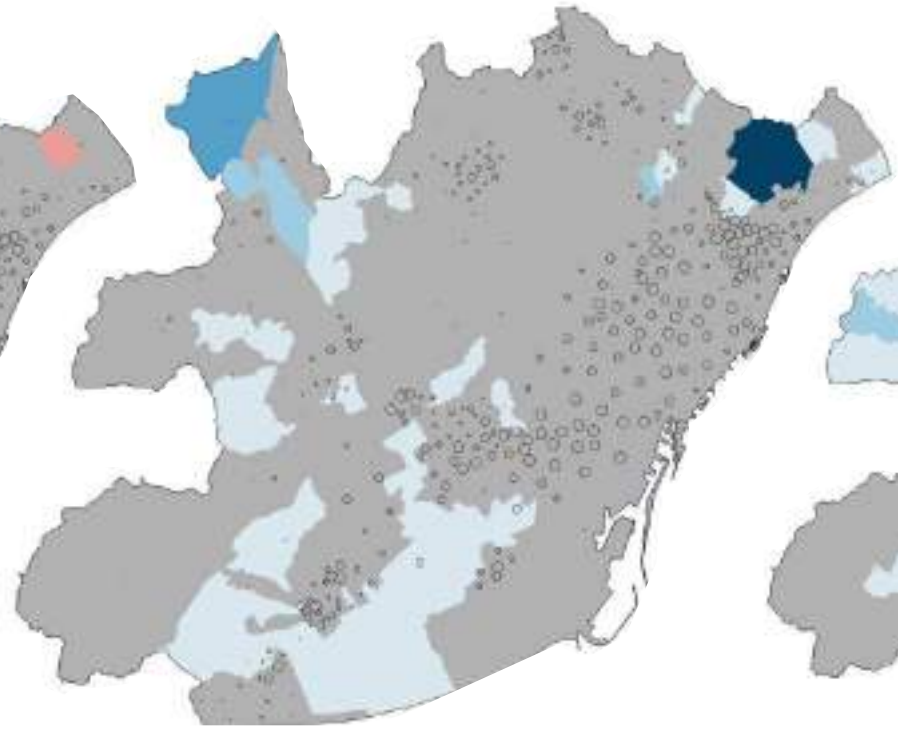
S1. Trending



- 0.9%

S0: 7.1%.; S1: 6.2%

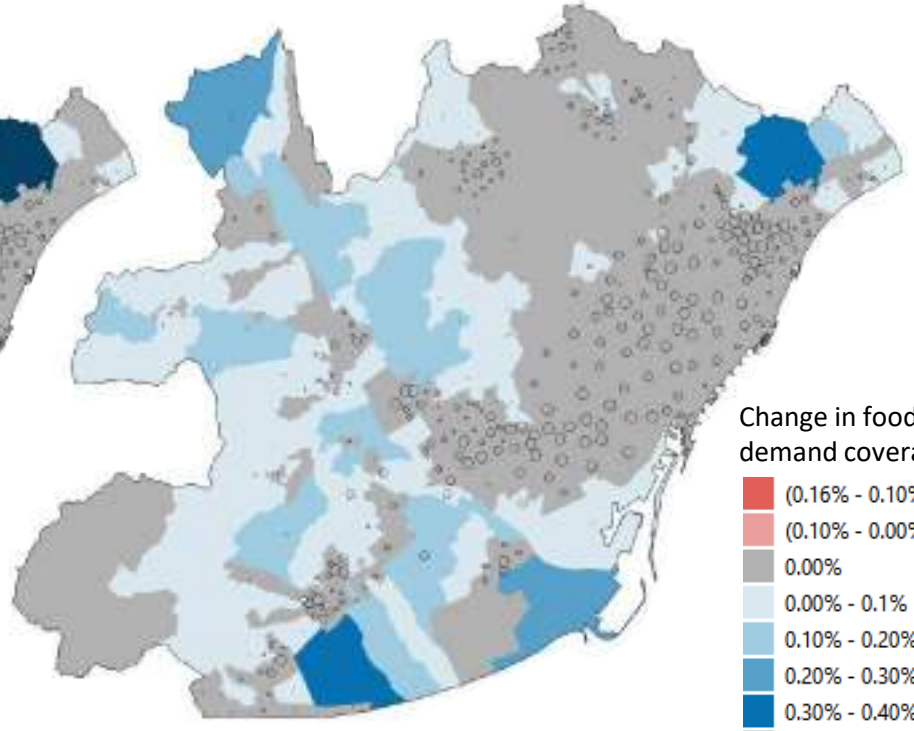
S2. Alternative



+ 1.9%

S0: 7.1%.; S1: 8.9%

S3. Potential



+ 5.8%

S0: 7.1%.; S3: 12.9%

Change in food demand coverage (%)

- (0.16% - 0.10%)
- (0.10% - 0.00%)
- 0.00%
- 0.00% - 0.1%
- 0.10% - 0.20%
- 0.20% - 0.30%
- 0.30% - 0.40%
- 0.40% - 0.50%
- 0.50% - 0.56%

Overall change in coverage of food demand of fruits and vegetables by local production(%)

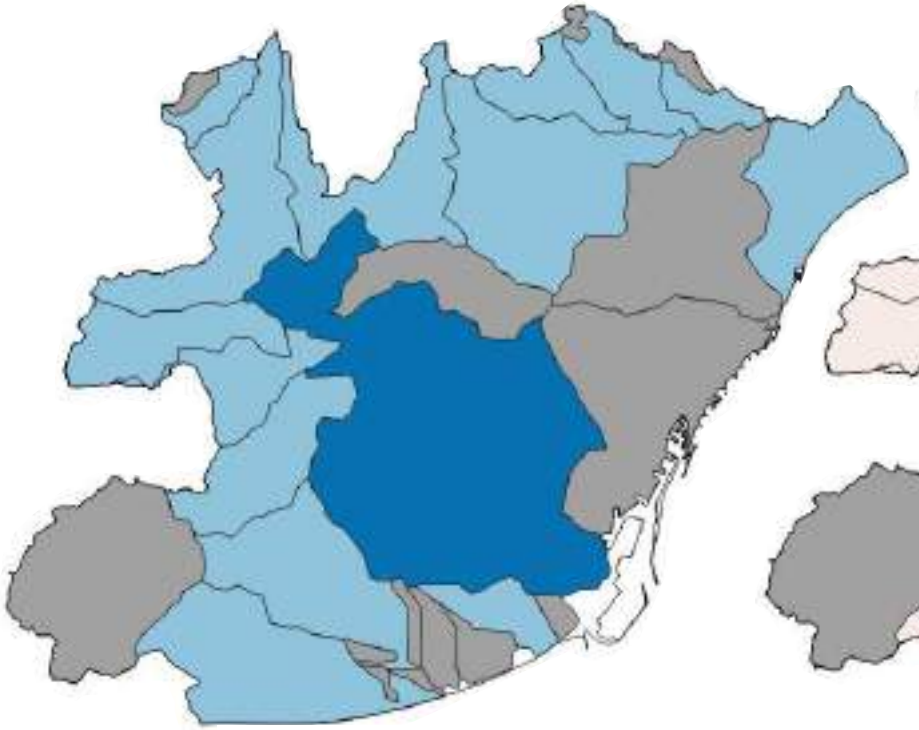
Total pop density (h/km2)

- 95 - 4,902
- 4,902 - 14,297
- 14,297 - 25,401
- 25,401 - 41,384
- 41,384 - 84,498

# Environmental impacts of fertilizer use

*Current state VS possible future scenarios*

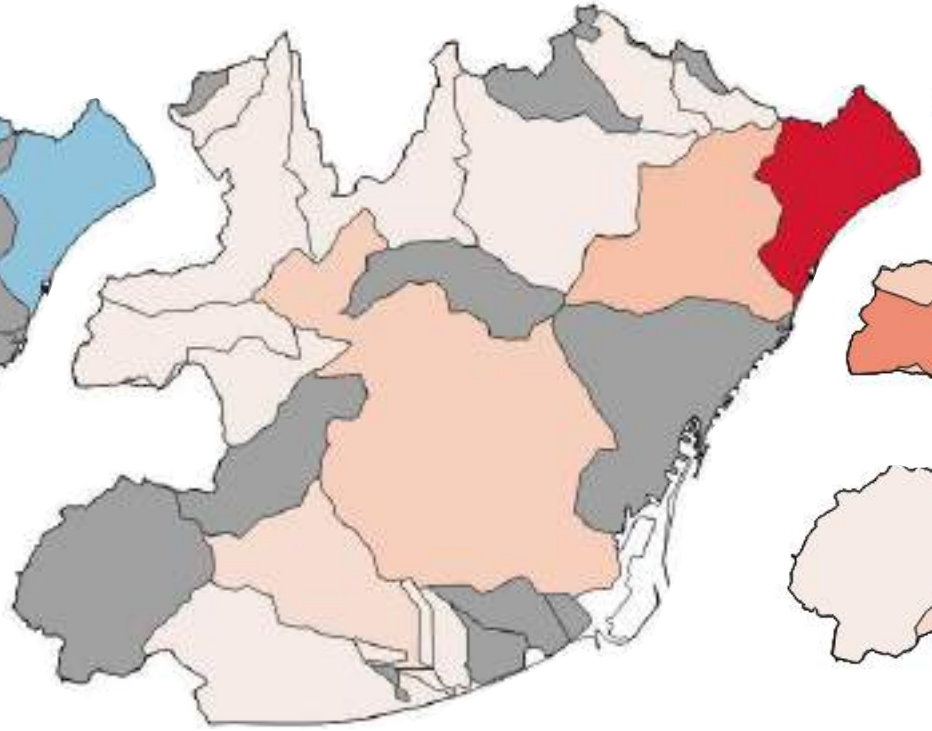
S1. Trending



- 3.57 kg P.

S0: 34.24 kg P.; S1: 30.66 kg P.

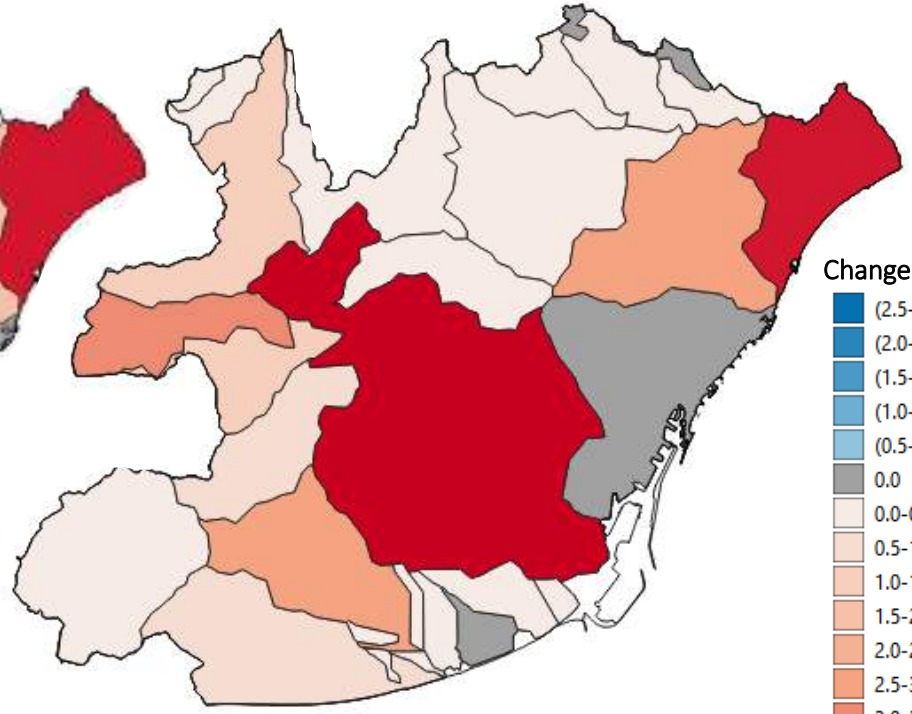
S2. Alternative



+10.81 kg P.

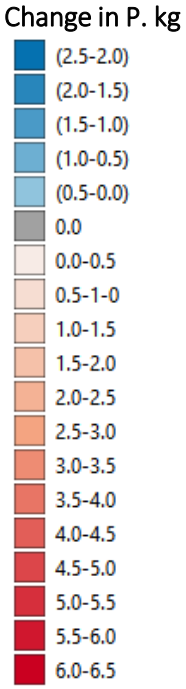
S0: 34.24 kg P.; S2: 45.05 kg P.

S3. Potential



+ 27.34 kg P.

S0: 34.24 kg P.; S3: 61.58 kg P.




Change in total Phosphorus kg. emitted by urban agriculture (S0 vs. S1, S2, S3)

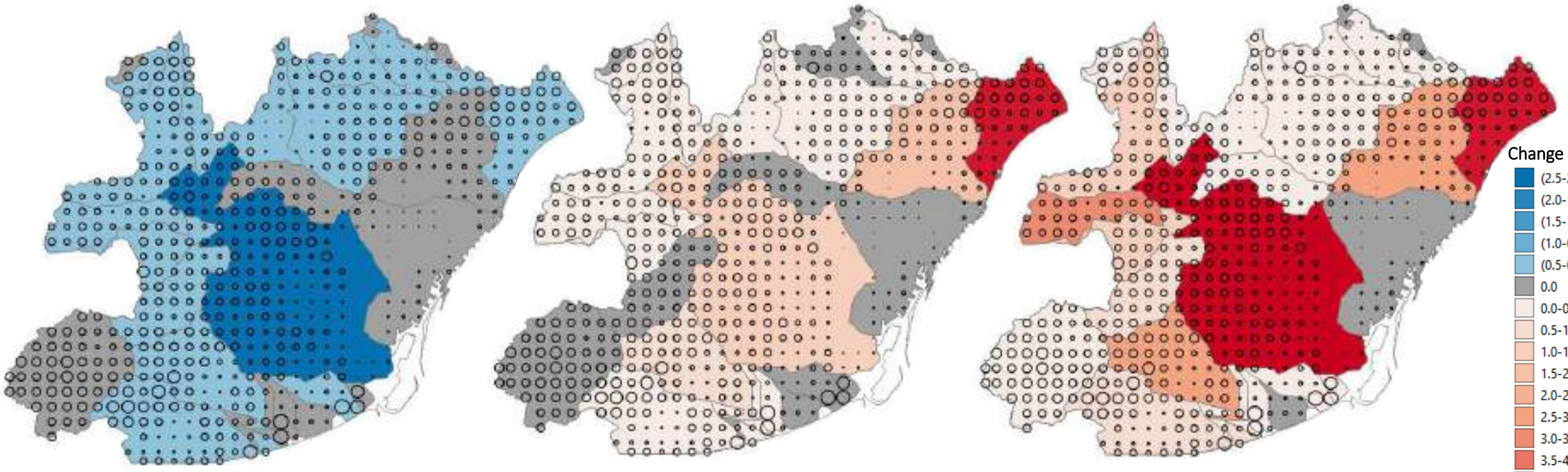
# Environmental impacts of fertilizer use

*Current state VS possible future scenarios*

S1. Trending

S2. Alternative

S3. Potential




- 3.57 kg P.

S0: 34.24 kg P.; S1: 30.66 kg P.

+10.81 kg P.

S0: 34.24 kg P.; S2: 45.05 kg P.

+ 27.34 kg P.

S0: 34.24 kg P.; S3: 61.58 kg P.

Change in total Phosphorus kg. emitted by urban agriculture

# Overall vulnerabilities

# Overall vulnerabilities

Heat conditions and exposure

+

Spaces for cultural and recreational experiences

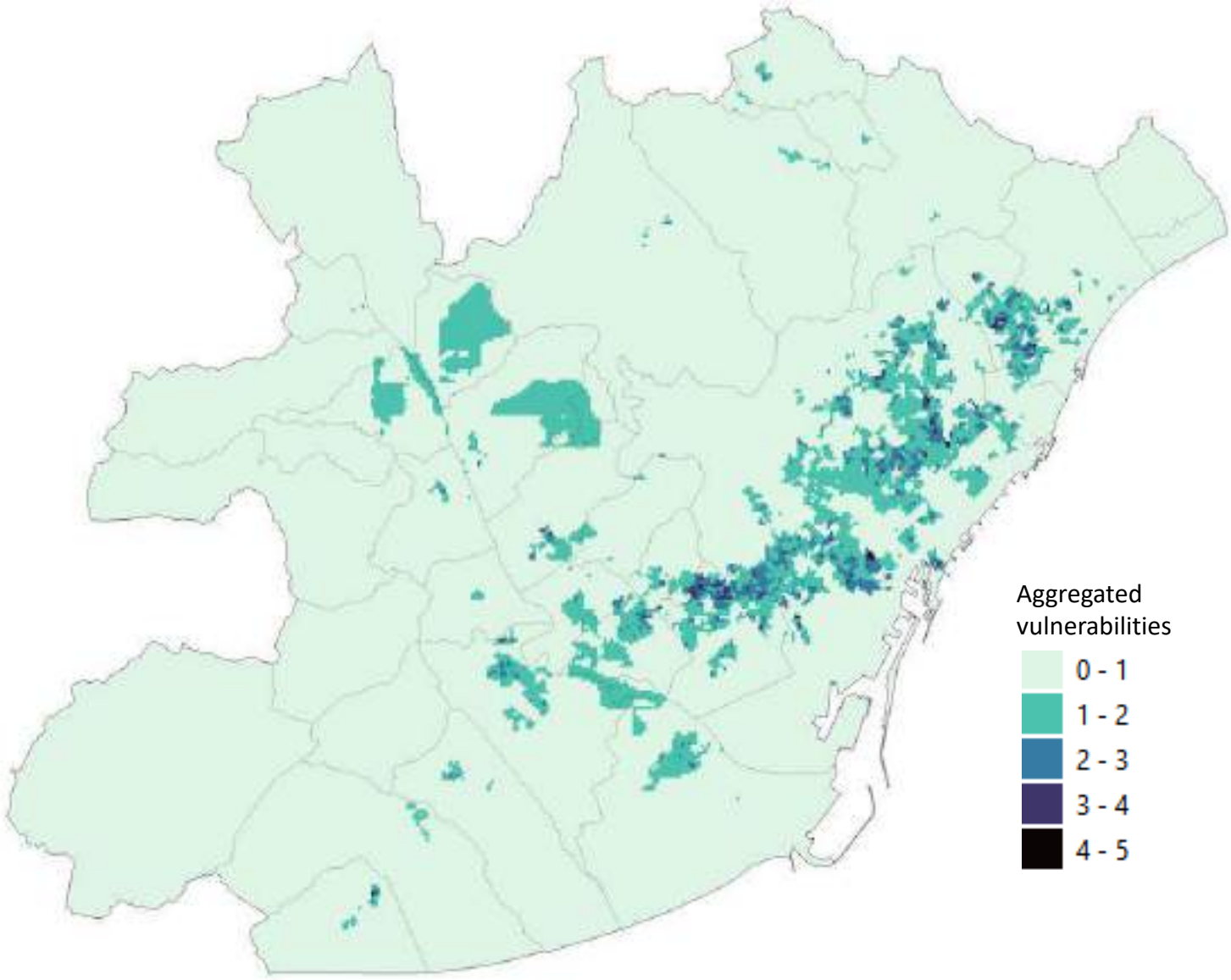
+

Food self-sufficiency

+

Environmental impacts of fertilizer use

=



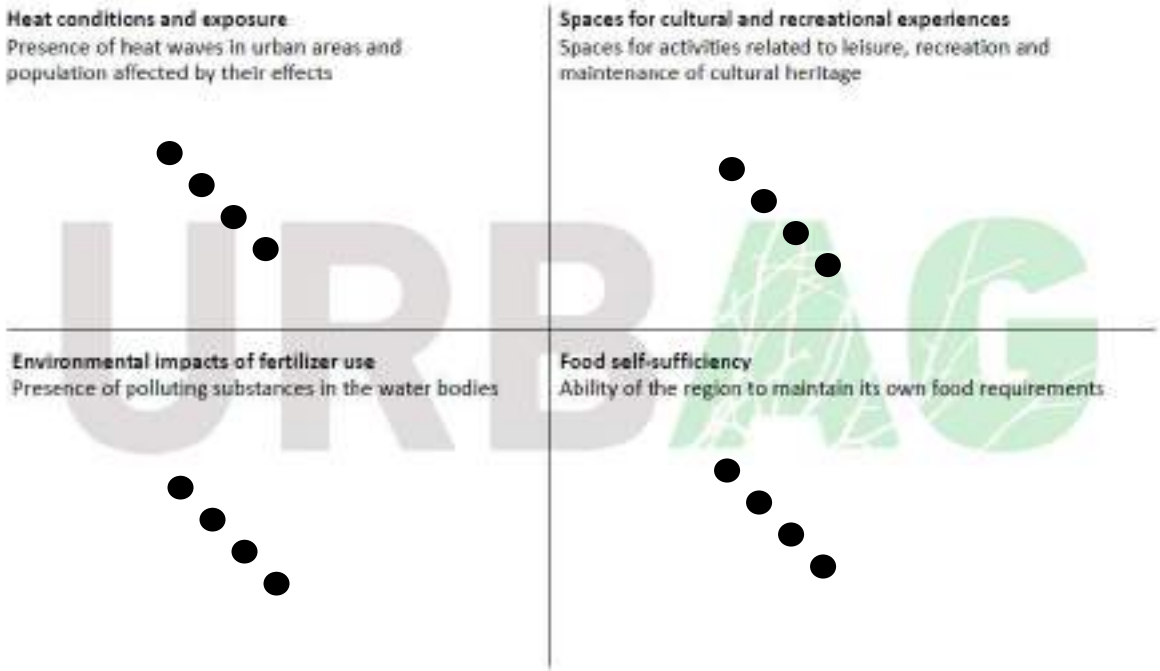
# Participatory exercise

**~ 20 minutes**

**Objective**: discuss and weight the relevance of each criterion when assessing the impacts of peri urban agriculture areas in the Metropolitan Area of Barcelona

**How?**

1) Split in groups of 5 people
2) Individually, assign pebbles among criteria (more pebbles -> more relevant the criterion)
3) As a group, discuss the results
4) Redistribute pebbles if necessary



**EU Horizon2020 ERC consolidator grant (818002-URBAG):**
***Integrated System Analysis of Urban Vegetation and Agriculture***
**(www.urbag.eu)**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URBAG Integrated System Analysis of Urban Vegetation and Agriculture