

# Barcelona SUDS STRATEGY

**SUDS COMMISSION – BARCELONA CITY COUNCIL**

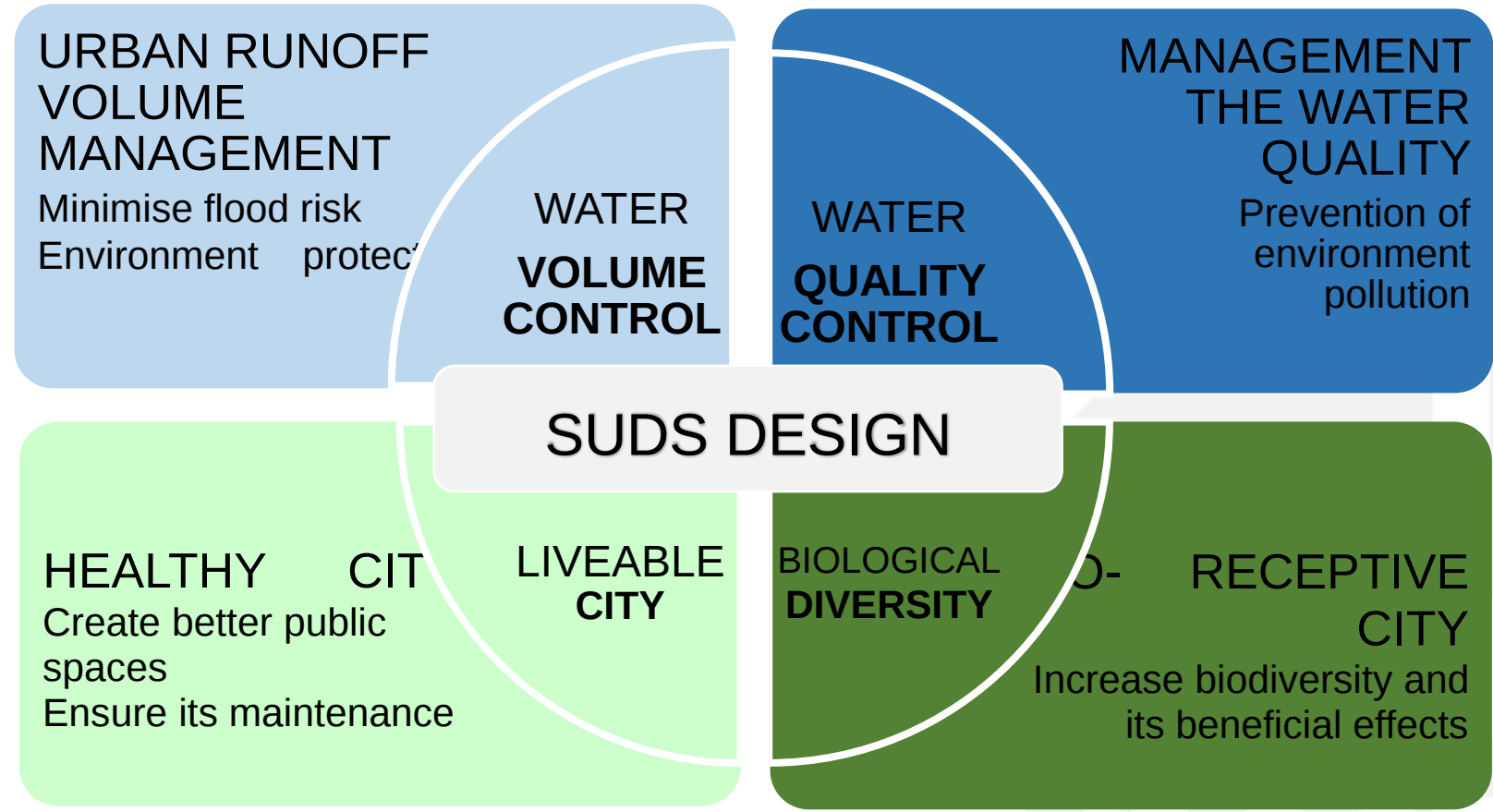


## WHAT ARE SUDS?

SUDS *Sustainable Urban Drainage Systems*, are alternative solutions to conventional drainage, which allow reproducing in the urban environment, the natural behaviour of water runoff.

- 🌿 Nature based solutions
- 🌿 Decentralised management
- 🌿 Visible management by citizens

- Water as a natural resource
- Integration into the urban landscape
- Design oriented towards ecosystem services.
- Creation of multifunctional spaces
- Diversity of techniques
- Solutions adapted to the site
- Habitat creation
- Increasing biomass and biodiversity



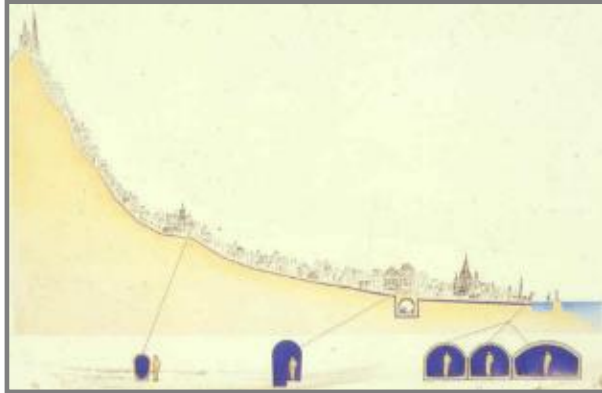
Own elaboration from The 4 pillars of SUDS Design (CIRIA, 2015)



## WHY DO WE NEED SUDS?

## URBAN RUNOFF VOLUME MANAGEMENT – PREVENT FLOODS

Collserola  
mountain



Llobregat River

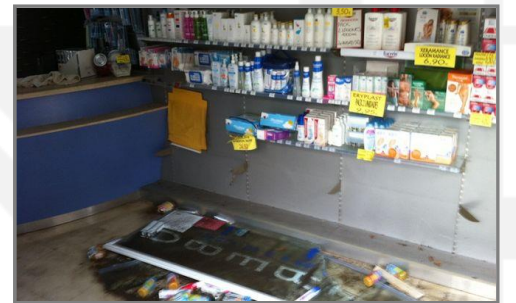
**Mediterranean rain regime:**  
high intensity storms  
**High density of population:**  
1.6Mhab/98km<sup>2</sup>  
**High land imperviousness**

Runoff  
preferred  
direction

Besòs River

Low gradients  
and critical points  
**FLOODS**

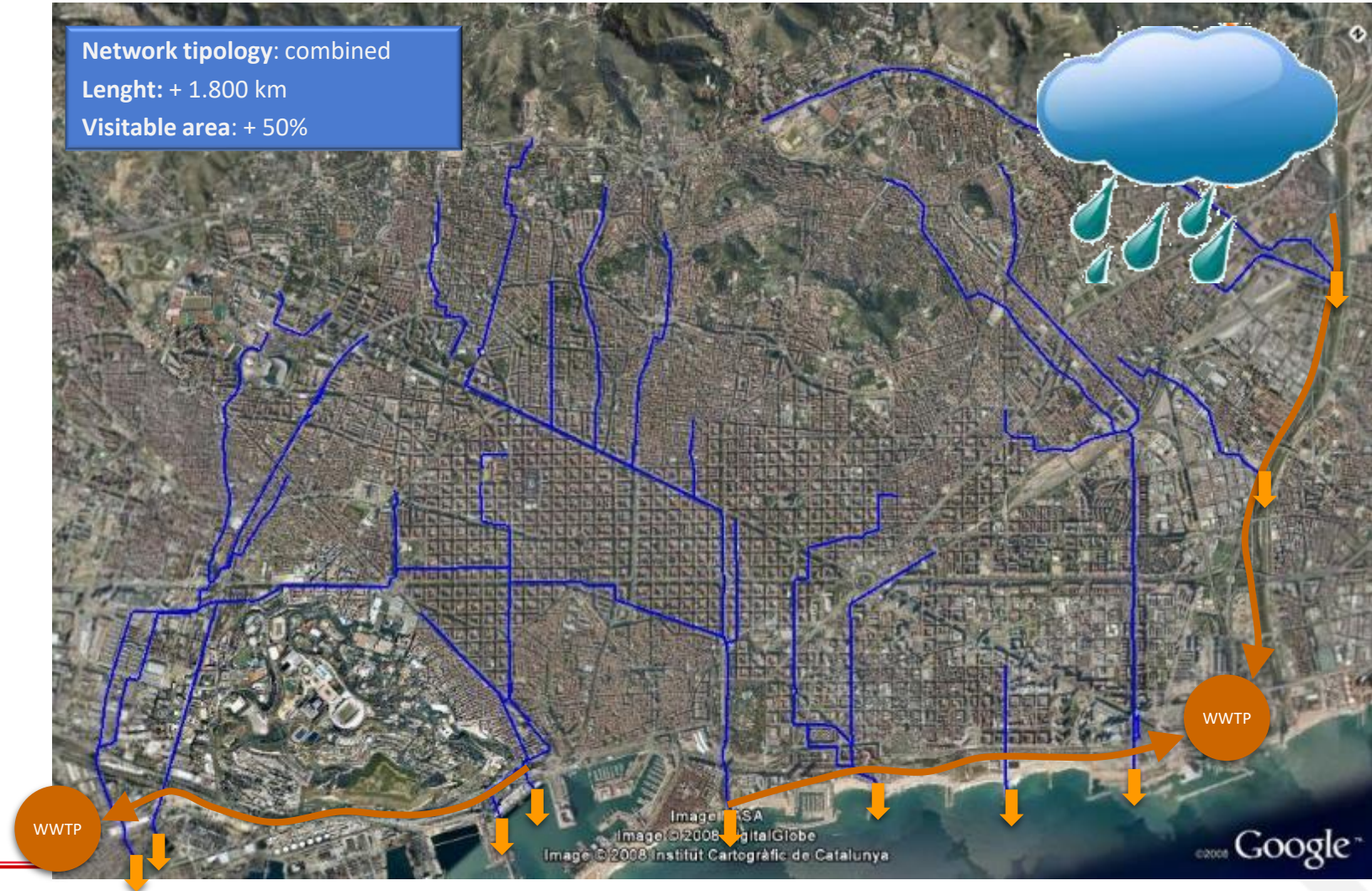
Mediterranean Sea





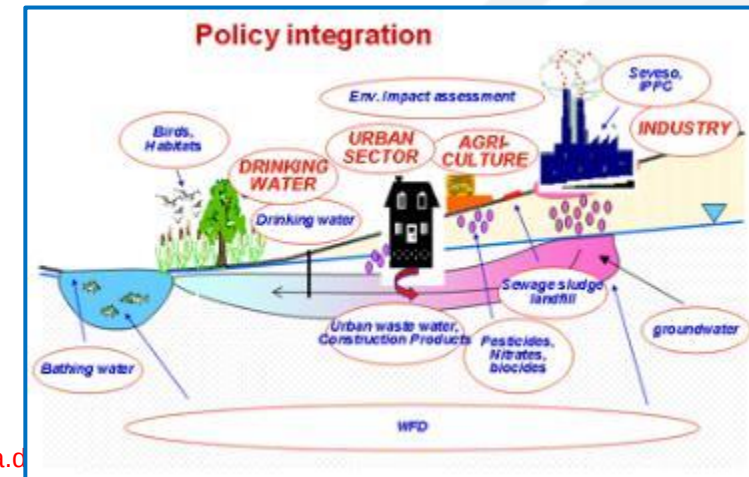
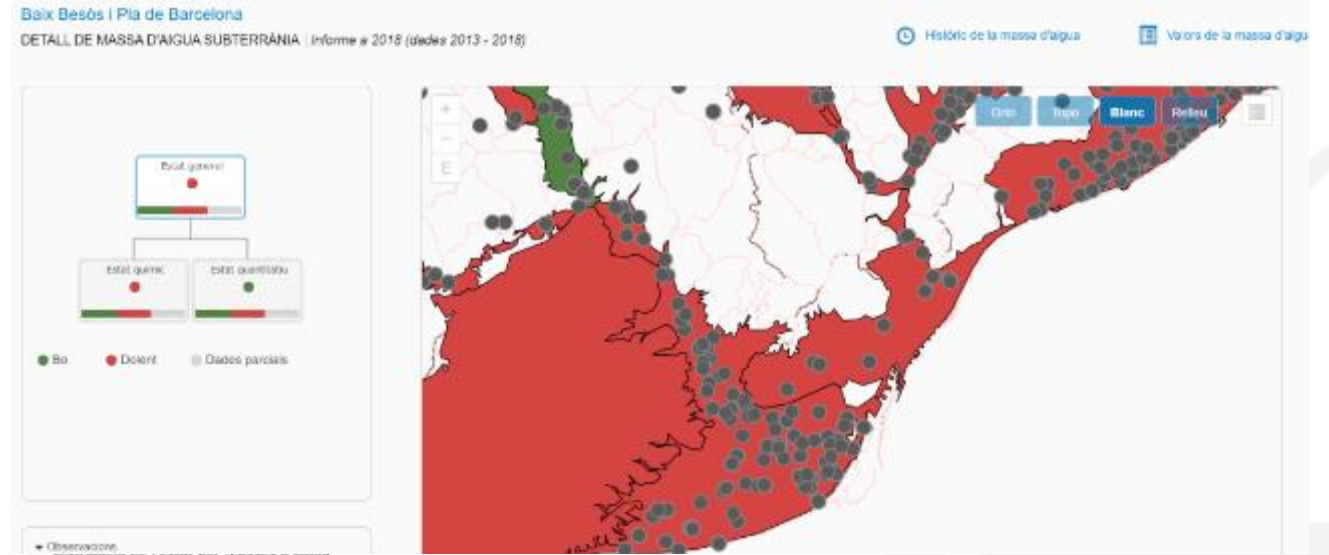
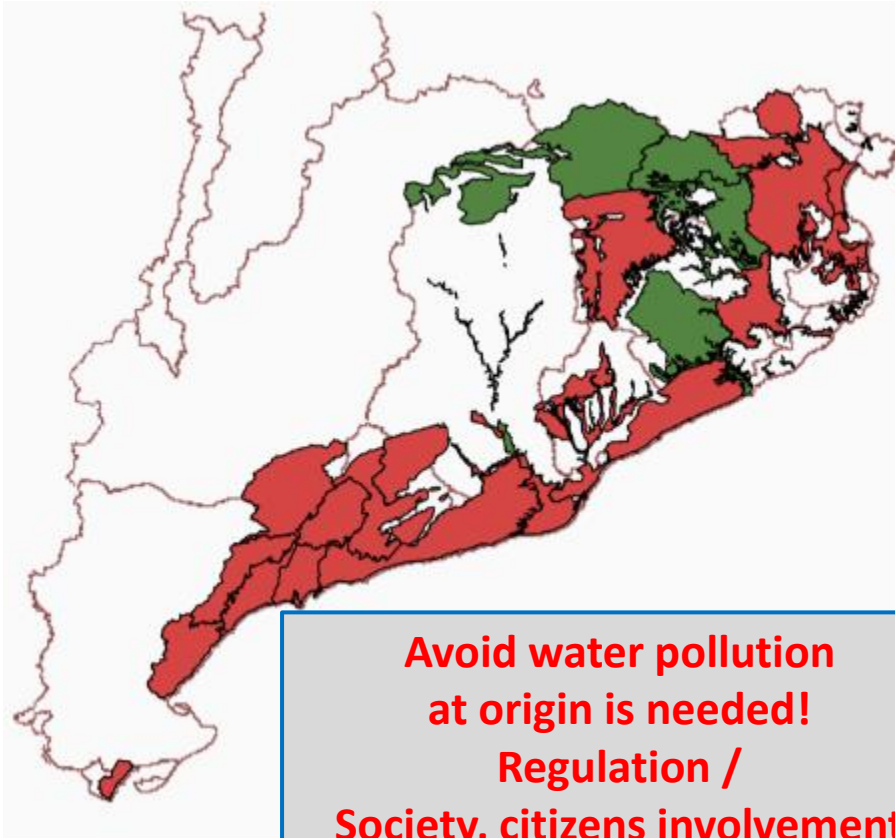
## WHY DO WE NEED SUDS?

## URBAN RUNOFF VOLUME MANAGEMENT – MINIMISE CSO



## WHY DO WE NEED SUDS?

## GROUNDWATER QUALITY – IMPROVE WATER BODIES STATUS



Groundwater quality status Catalonia WFD <http://aca-web.gencat.cat/WDMA/novaCerca.c>



## WHY DO WE NEED SUDS?

## LIVEABLE CITIES – HEALTH AND WELL-BEING



Parc de Joan Raventós



## WHY DO WE NEED SUDS?

## BIORECEPTIVE CITIES – BENEFICIAL EFFECTS OF BIODIVERSITY



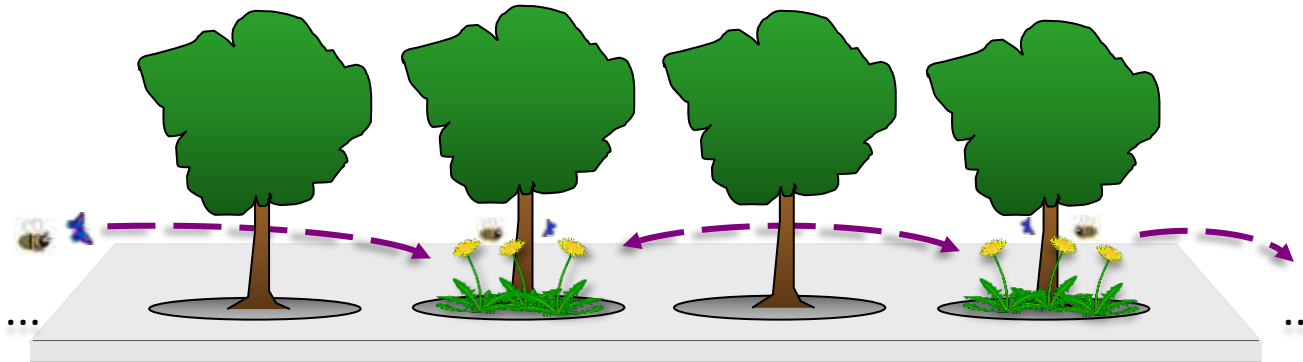
Marina del Prat Vermell

## BIORECEPTIVE CITIES – BENEFICIAL EFFECTS OF BIODIVERSITY

Designed  
ecology:  
Transforming  
gardens into  
flora and fauna  
habitats



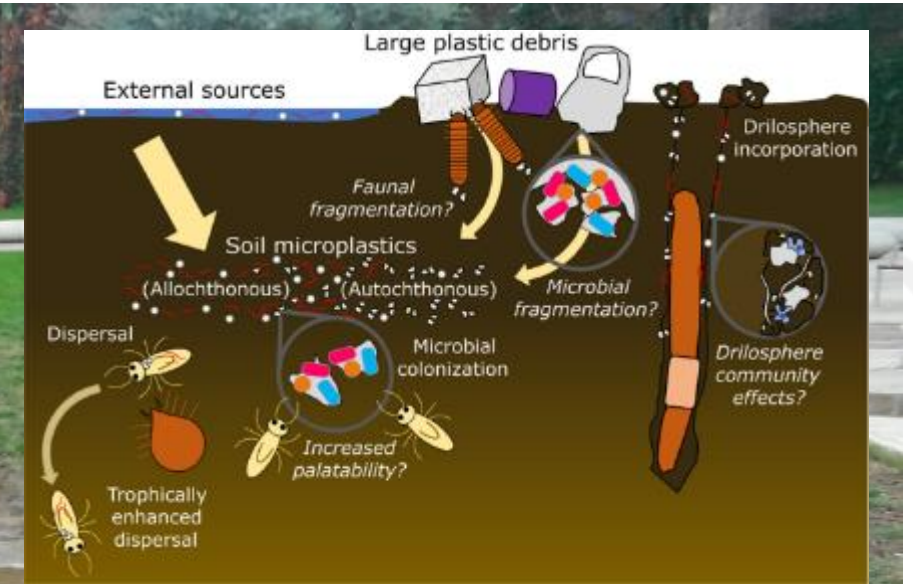
Carballo, G.; Escuer, L.; 2019



Micro-habitat ecological corridor

Create and  
connect biomass  
and biodiversity  
through habitat  
mosaics

# BIORECEPTIVE CITIES – BENEFICIAL EFFECTS OF BIODIVERSITY



Impact of microplastics on soil biota. Helmberger, 2019

## SOILS HOST A QUARTER OF OUR PLANET'S BIODIVERSITY

Soil is one of nature's most complex ecosystems: it contains a myriad of organisms which interact and contribute to the global cycles that make all life possible.

A typical healthy soil might contain:

- vertebrate animals
- earth worms
- nematodes
- 20-30 species of mites
- 50-100 species of insects
- hundreds of species of fungi
- thousands of species of bacteria & actinomycetes

FAO, 2015

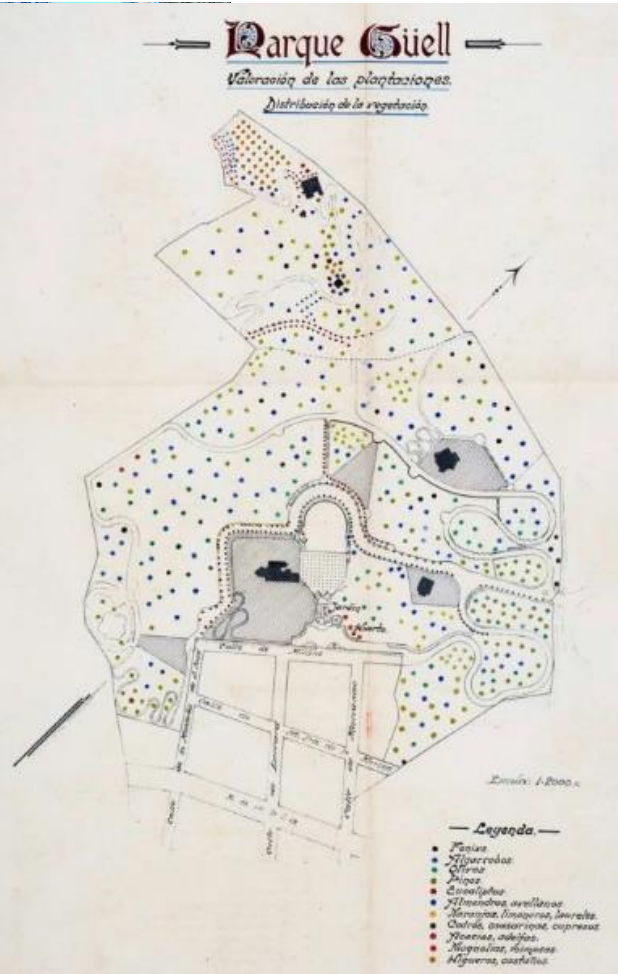
Over 1000 species of invertebrates may be found in 1 m<sup>2</sup> of forest soils.

Biodiversity is essential for food security and nutrition.

**Soils retain more carbon than all vegetation and the atmosphere**

## HOW DO WE MANAGE THE PARADIGM SHIFT?

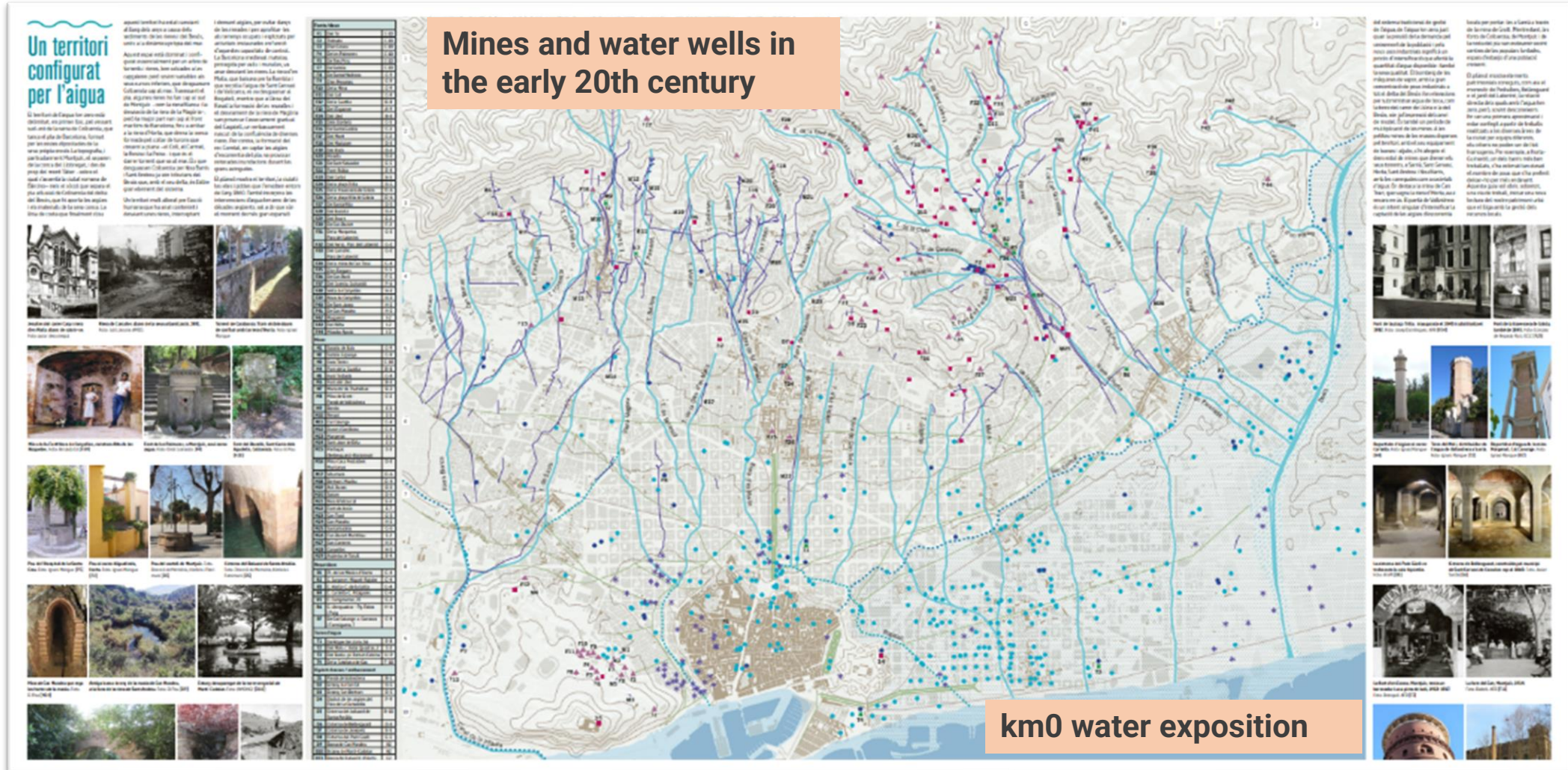
BUILDING ON NATURE, UNDERSTANDING WATER BEHAVIOUR,  
RECOVERING TRADITIONAL TECHNIQUES, REACHING AGREEMENT



Park Güell – Antonio Gaudí. Incredible example of water-sensitive landscape design

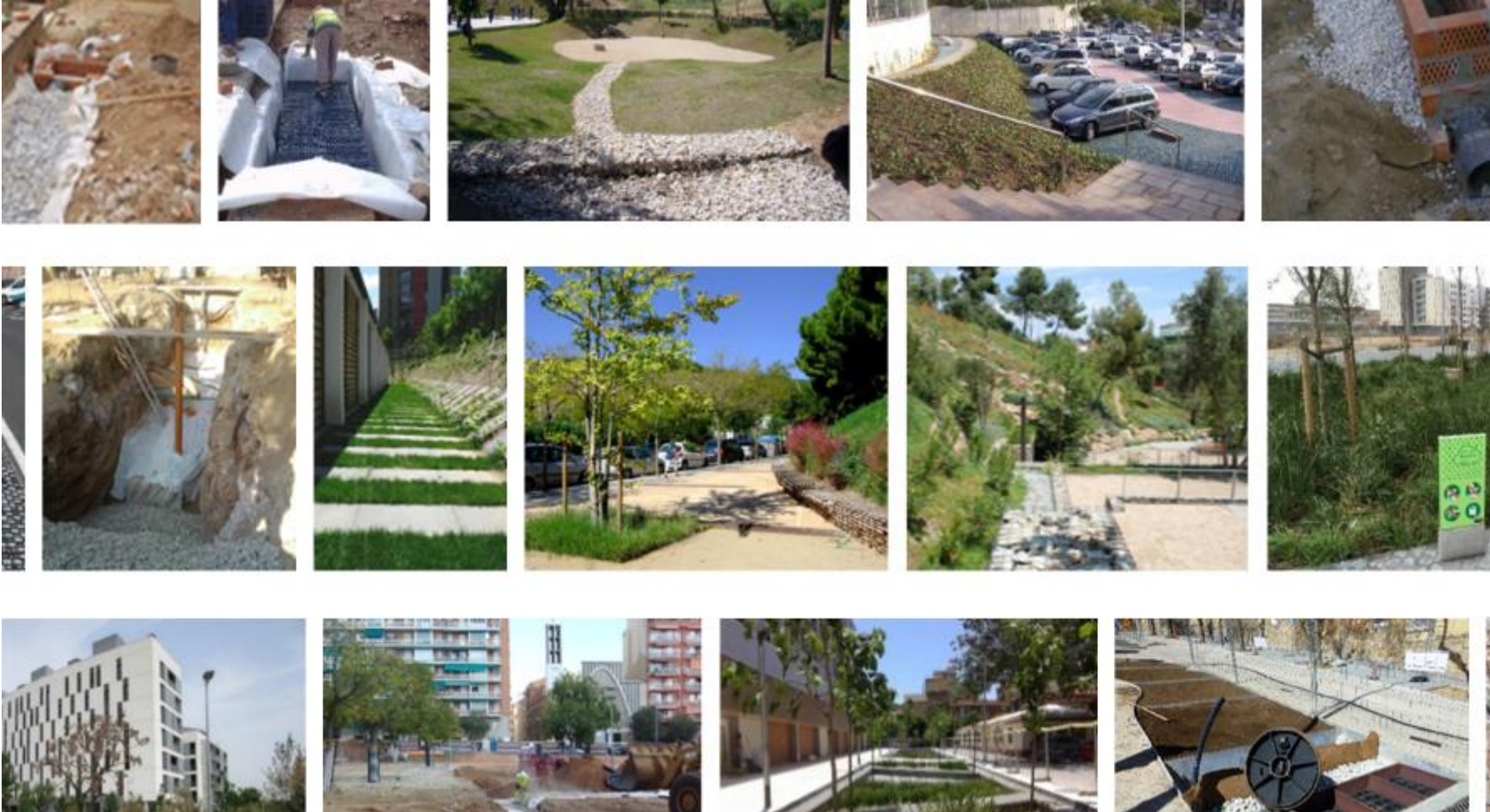
## HOW DO WE MANAGE THE PARADIGM SHIFT?

## BUILDING ON NATURE, UNDERSTANDING WATER BEHAVIOUR, RECOVERING TRADITIONAL TECHNIQUES, REACHING AGREEMENT



<https://ajuntament.barcelona.cat/museuhistoria/sites/default/files/guiaaiguakm0final.pdf>

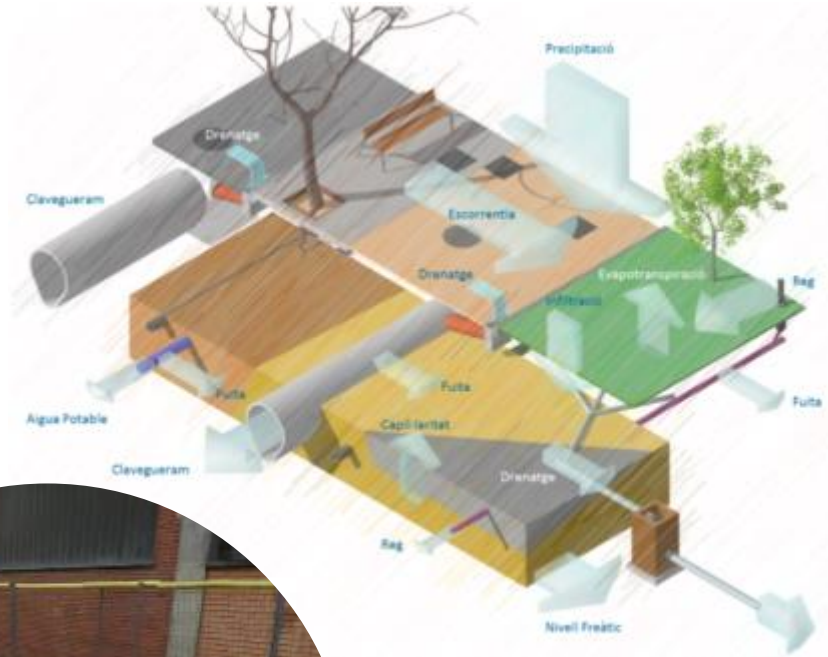
## SINCE 2005 SUDS HAVE BEEN BUILT IN BARCELONA



Different projects for urbanisation and remodelling of green spaces incorporate the philosophy of decentralised rain management with SUDS.



C/ Cristòfol de Moura



**SUDS may have various forms**



- ⌚ Depavimentation programmes
- ⌚ Paviments permeabilisation
- ⌚ Structured soils

**SUDS can be applied in new or existing developments (G Carballo, 2012)**

## SUDS COMMISSION OF BARCELONA CITY COUNCIL

Barcelona begins to implement SUDS in 2005. The SUDS Commission was established in 2016.

**Entities initiating the commission:**

Barcelona Water Cycle

Parks and Gardens Institute

Municipal Urbanism Institute

Urban Projects

Sustainability Office

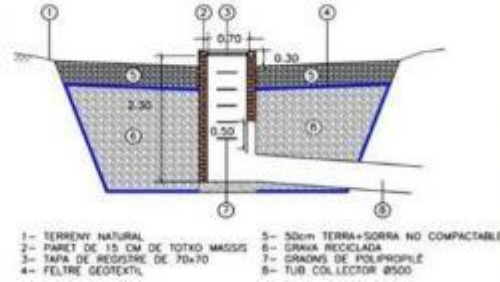
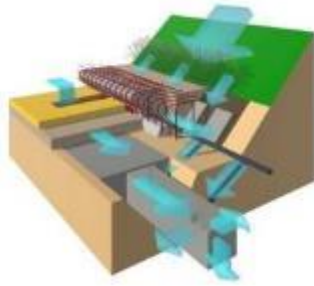
Mobility and Infrastructure

Health Public Agency

**The functions of the commission are:**

- Promote studies on the implementation, management and follow-up of SUDS.
- Systematize data management and projects related to SUDS techniques.
- Promote training in municipal technical services.
- To promote information to the citizenry, through signage, holding of conferences, on-line information.
- Sharing in the municipal organization about the SUDS benefits.
- SUDS Master Plan Coordination.

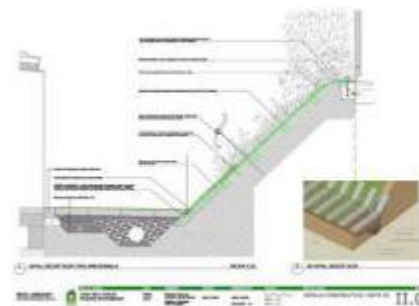
## 1. Design and implementation in scattered projects.



## 2. Individual research.

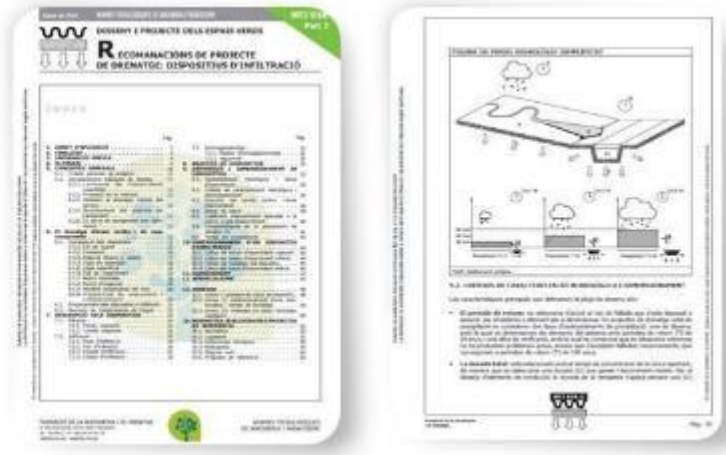


## 3. No design specification or maintenance.



PILOT PHASE

## 1. Drafting Gardening Technical Standard on infiltration systems (NTJ)



## 2. Projects and experiences dissemination



ACCEPTANCE STAGE



# 1. Compilation of experiences of different municipal operators.



# 2. Establishment of the SUDS Commission.



# 3. Report on the SUDS of Barcelona.



INTEGRATION PHASE



## 1. Promotion of SUDS in unique projects



## 2. Study of the potential of rainwater use with SUDS.



## 3. Manual of Maintenance of SUDS.

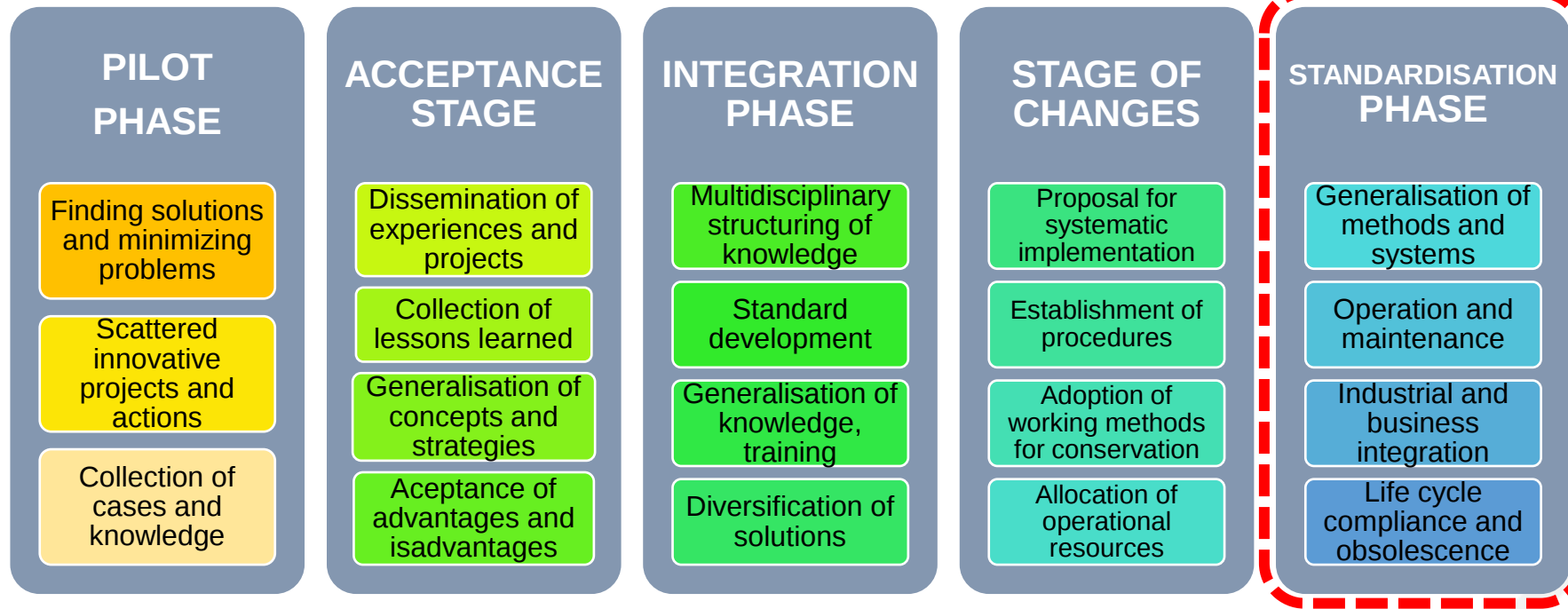


| Índice                   | Contenido                       | Responsable                             | Fecha de actualización |
|--------------------------|---------------------------------|-----------------------------------------|------------------------|
| 1. Introducción          | Objetivo del manual             | Departament d'Enginyeria i Arquitectura | 2018                   |
| 2. Definición de SUDS    | Conceptos básicos               | Departament d'Enginyeria i Arquitectura | 2018                   |
| 3. Tipos de SUDS         | Tipología de sistemas           | Departament d'Enginyeria i Arquitectura | 2018                   |
| 4. Diseño de SUDS        | Procedimientos de diseño        | Departament d'Enginyeria i Arquitectura | 2018                   |
| 5. Mantenimiento de SUDS | Procedimientos de mantenimiento | Departament d'Enginyeria i Arquitectura | 2018                   |
| 6. Anexo                 | Documentos de referencia        | Departament d'Enginyeria i Arquitectura | 2018                   |



STAGE OF CHANGES

## THE BARCELONA CITY COUNCIL SUDS COMMISSION MAKES PARADIGM SHIFT POSSIBLE



## PLARHAB 2020 – PDISBA 2020

### LA 6. ACTION LINE SUDS

#### OBJECTIVE:

Manage rains

$P < 15 \text{ mm}$



$V_{80}$  ( 80% rainfall episodes  
of an average year)

$V \text{ potential} = 7,94 \text{ hm}^3/\text{year}$

$V \text{ managed} = 5,71 \text{ hm}^3/\text{year}$



#### CONDITIONS OF PUBLIC SPACE

ROADS  
SLOPE  $< 6\%$   
WIDTH  $> 9 \text{ m}$



696 km STREETS

PARKS AND  
GARDENS



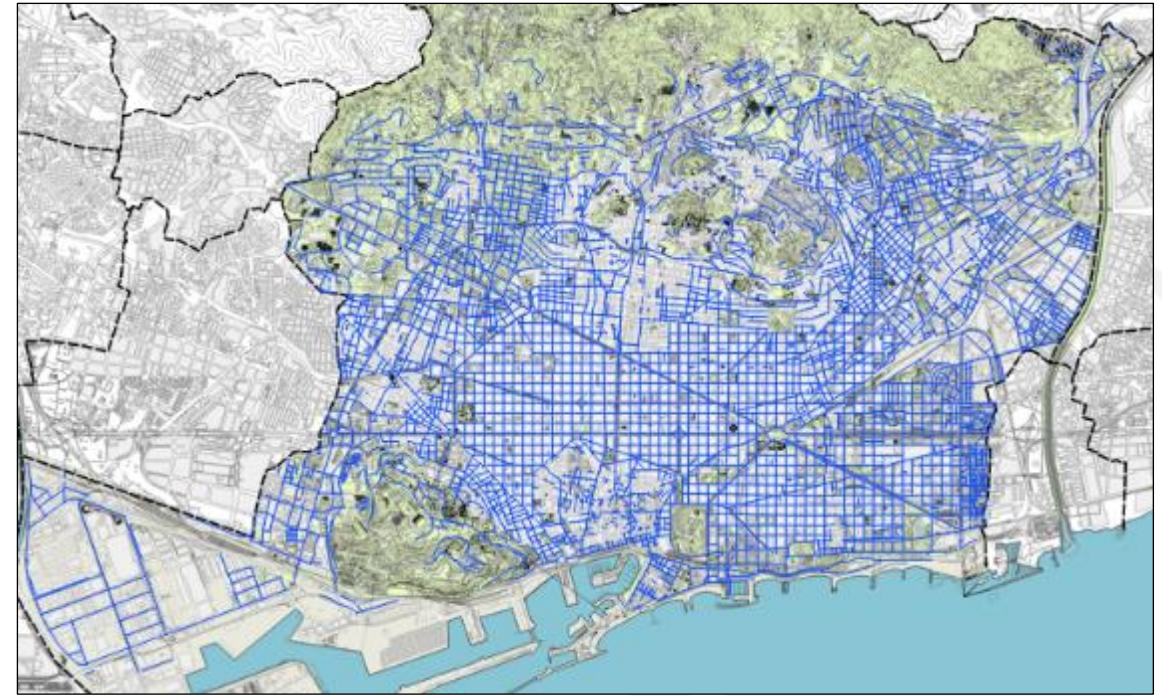
1295 ha  
(forest area not included)

| Type | Denomination              | Width (m) | Slope % |
|------|---------------------------|-----------|---------|
| 1    | Narrow and m.slope        | 9 a 15    | 0 – 2,5 |
| 2    | M.width and low slope     | 15 a 40   | 0 – 1   |
| 3    | M.width and m.slope       | 15 a 40   | 1 – 2,5 |
| 4    | M.width and large slope   | 15 a 40   | 2,5 – 6 |
| 5    | Large width and low slope | 40        | 0 – 2,5 |
| 6    | Green spaces              | -         | -       |



## PLARHAB 2020 – PDISBA 2020

### LA 6. ACTION LINE SUDS



### MANAGED VOLUME AND POLLUTANTS RETAINED

| Denomination             | TECHNIQUES           | Àrea<br>SUDS total (m <sup>2</sup> ) | Volume<br>Managed<br>(m <sup>3</sup> /any) | Pollutants<br>retained<br>(Kg/any) |
|--------------------------|----------------------|--------------------------------------|--------------------------------------------|------------------------------------|
| ONLY SIDEWALK            | Water parterres      | 947.451                              | 2.622.006                                  | 18.905                             |
| SIDEWALK AND DRIVEWAY    | Bio-retention strips | 1.421.867                            | 5.716.117                                  | 783.917                            |
| SUPERBLOCK GREEN RESERVE | Bio-retention strips | 2.828.896                            | 5.876.299                                  | 795.246                            |
| PARCKS AND GARDENS       | Water parterres      | 585.920                              | 2.987.737                                  | 21.207                             |

PDISBA - <https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/119275>; PLARHAB: <https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/121158>

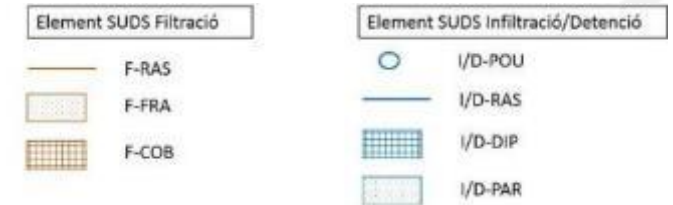
# INVENTORY AND CARTOGRAPHY – GIS; MAINTENANCE PLATFORM - GMAO

## 1 – DATA MODEL DESIGN

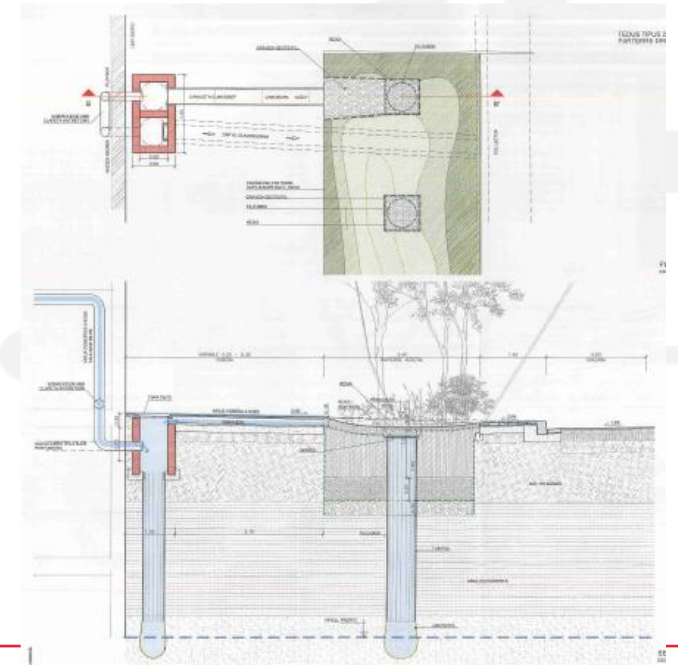
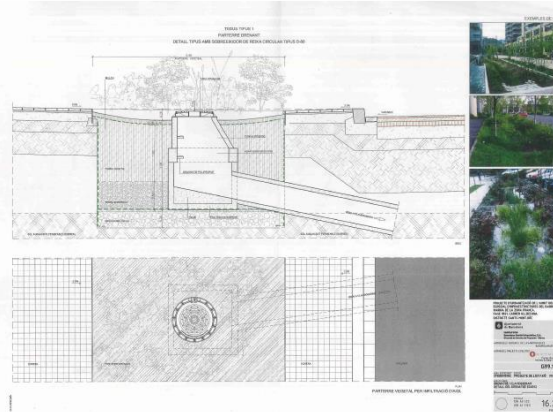
|    |                                        | Origen natural |           |       |       | Origen Artificial |       |                      |         | Camps únics |            |       |       |       |              |
|----|----------------------------------------|----------------|-----------|-------|-------|-------------------|-------|----------------------|---------|-------------|------------|-------|-------|-------|--------------|
|    |                                        | Retenció       | Filtració |       |       | Infiltració       |       | Infiltració/Detenció |         |             | Tractament |       |       |       |              |
|    | Tipologia de SUD                       | R-ALJ          | F-RAS     | F-FRA | F-COB | I-PAV             | I-ESC | I-D-POU              | I-D-RAS | I-D-DIP     | I-D-PAR    | T-CUN | T-EST | T-BIO |              |
| 17 | Longitud                               |                | X         | X     |       |                   |       | ?                    |         |             | ?          | X     |       | ?     | CAMPS COMUNS |
| 18 | Ample                                  |                | X         | X     |       |                   |       | ?                    |         |             | ?          | X     |       | ?     |              |
| 19 | Accés                                  |                | X         | X     |       |                   |       | X                    | ?       | X           |            | X     | X     |       |              |
| 20 | Superfície geotèxtil                   |                | ?         | ?     | ?     | X                 | X     | ?                    | X       | X           | ?          | X     | X     | X     |              |
| 21 | Tipologia abocament (medi clauveg/SUD) |                | X         | X     | ?     |                   | ?     | ?                    | ?       | ?           | ?          | X     | ?     | ?     |              |
| 22 | Vegetació (SI/NO)                      |                | X         | X     | X     |                   | X     | ?                    | X       | X           | ?          | X     | ?     | ?     |              |
| 23 | Tipus vegetació                        |                | X         | X     | X     |                   | X     | X                    | ?       | X           | X          | X     | X     | X     |              |
| 24 | Fondària capa 1-terra vegeta           |                | X         | X     | X     |                   | X     | X                    | ?       | X           | X          | X     | ?     | X     |              |
| 25 | Fondària capa 2                        |                | X         | X     | X     | X                 | X     | X                    | ?       | X           | X          | X     | ?     | X     |              |
| 26 | Granulometria capa 2                   |                | X         | X     | X     | X                 | X     | X                    | ?       | X           | X          | X     | ?     | X     |              |
| 27 | Cota nivell freàtic                    |                | X         | X     |       | X                 | X     | X                    | ?       | X           | X          | X     | X     | X     |              |
| 28 | Permeabilitat terreny                  |                | X         | X     |       | X                 | X     | X                    | ?       | X           | X          | X     | X     | X     |              |
| 30 | Tipologia tub dren                     |                | X         | ?     | X     | X                 | X     |                      |         |             |            |       |       |       |              |
| 31 | Diàmetre tub dren                      |                | X         | ?     | X     | X                 | X     |                      |         |             |            |       |       |       |              |
| 32 | Longitud tub dren                      |                | X         | ?     | X     | X                 | X     |                      |         |             |            |       |       |       |              |
| 33 | Períons registre                       |                | X         | ?     | X     | X                 | X     |                      |         |             |            |       |       |       |              |
| 34 | Dimensions períons                     |                | X         | ?     | X     | X                 | X     |                      |         |             |            |       |       |       |              |
| 35 | Cel·les drenatge (SI/NO)               |                | X         | ?     | X     | X                 | X     |                      | X       | X           |            |       |       |       |              |
| 36 | Dimensions cel·les                     |                | X         | ?     | X     | X                 | X     |                      | X       | X           |            |       |       |       |              |
| 37 | Buena                                  |                |           | X     |       |                   |       |                      |         |             |            |       |       |       |              |
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|    |                                        |                |           |       |       |                   |       |                      |         |             |            |       |       |       |              |

CAMPS COMUNS

DRENS



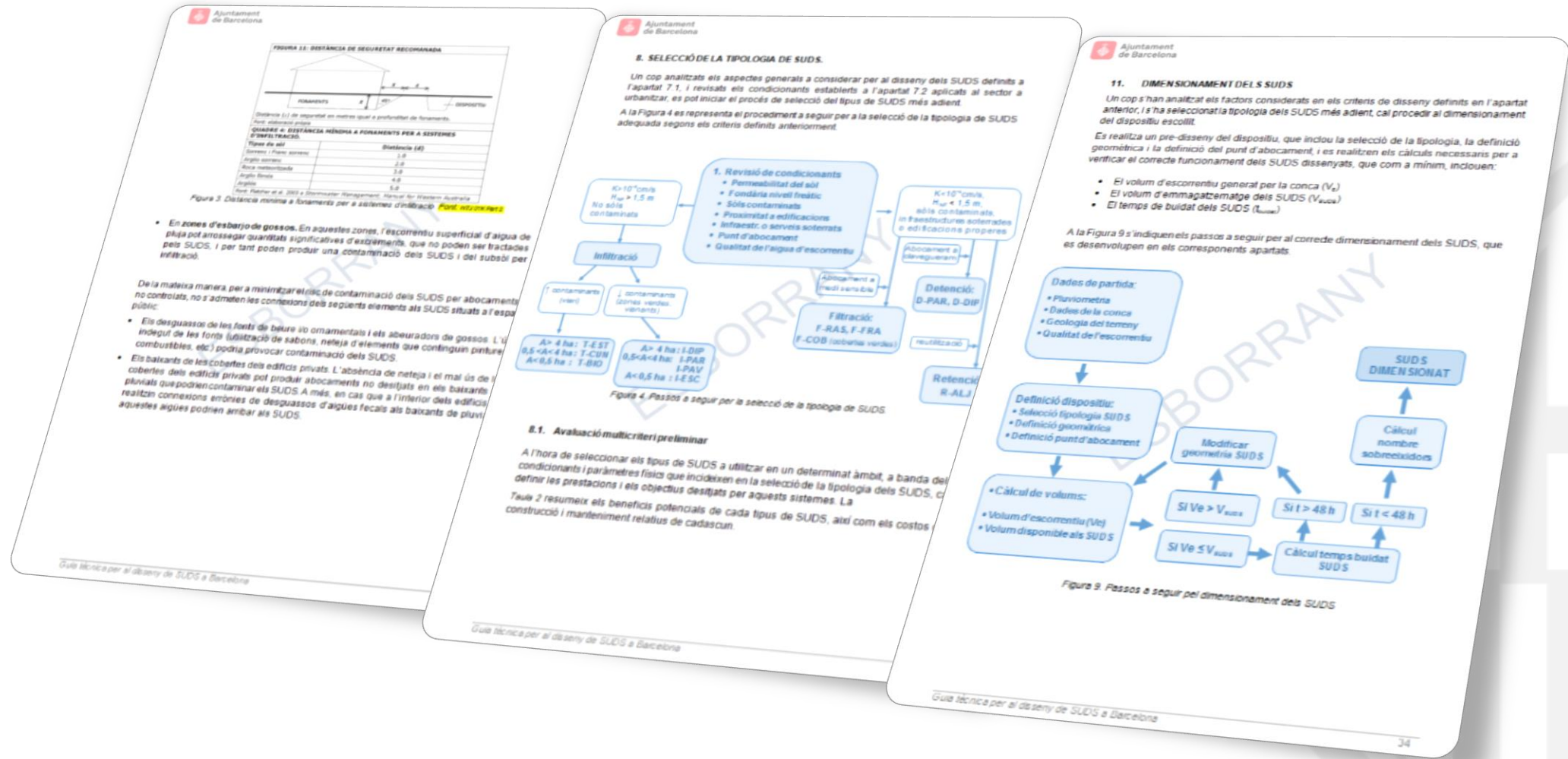
## 2 – STANDARISATION AS BUILT DOCUMENTATION





# TECHNICAL GUIDE FOR THE DESIGN OF SUDS (2020)

## STANDARDISATION PHASE



## GENERAL CRITERIA FOR SUDS DESIGN

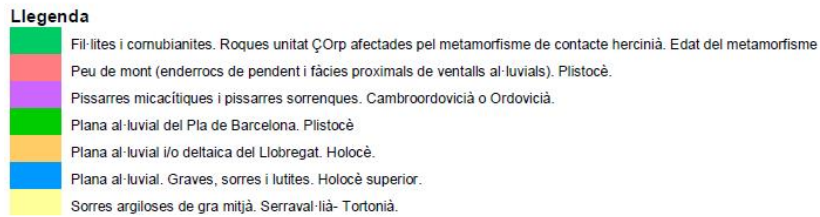
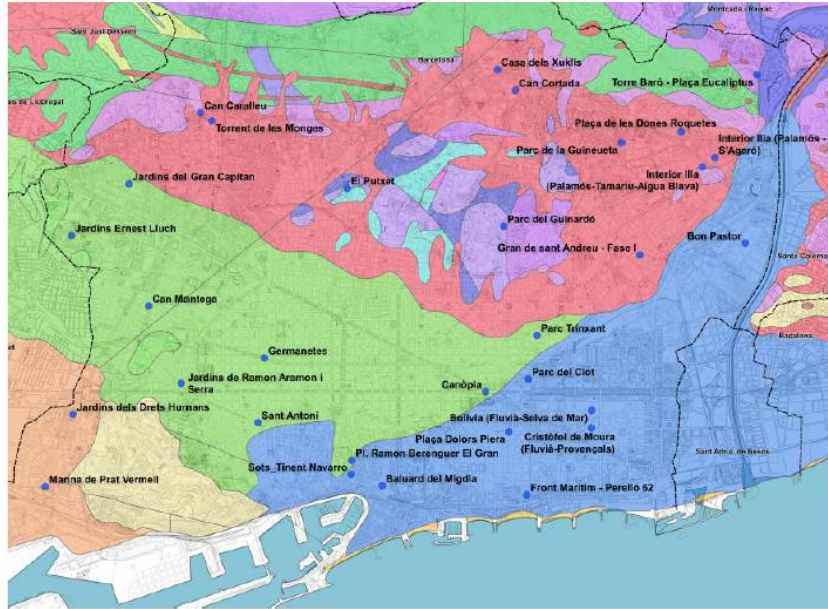
- Precipitation rate.
- Topography.
- Geology, soil science, water table, polluted soils.
- Water runoff quality.
- Other:
  - available space
  - public space configuration
  - use of the collected water
  - intensity of use public space
  - proximity areas of archaeological interest
  - density urban services
  - type of rainwater management



## Limitations of SUDS implementation

Infrastructural proximity  
Dog areas (pollution)

Proximity existing buildings  
Private building drains



## Geology

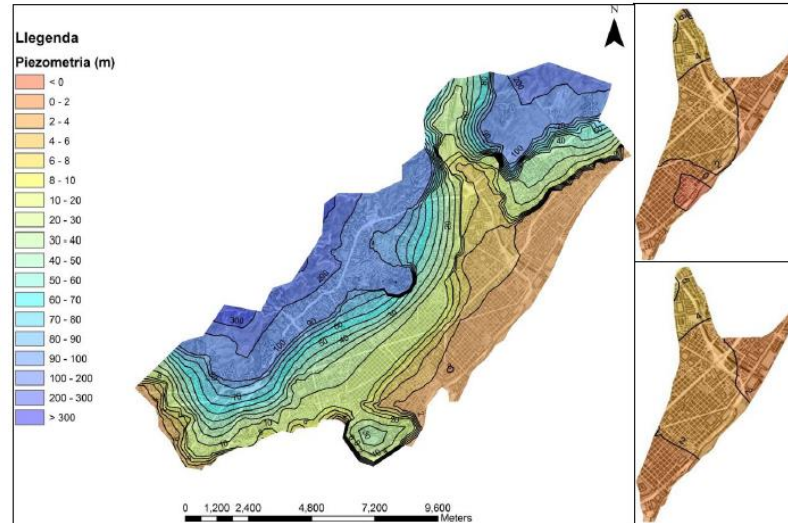


Figura 4. Mapes de piezometria als aqüífers superior (esquerra), mitjà (dalt dreta) i profund (baix dreta) a l'any 2017. (Font IDAEA-CSIC)

## Hydrogeology

## Permeability test



| USO DEL AGUA PREVISTO                                                                   | VALOR MÁXIMO ADMISIBLE (VMA) |                  |                          |                   |                                                                                                                                   |
|-----------------------------------------------------------------------------------------|------------------------------|------------------|--------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|                                                                                         | NEMATODOS<br>INTESTINALES    | ESCHERICHIA COLI | SÓLIDOS EN<br>SUSPENSIÓN | TURBIDEZ          | OTROS CRITERIOS                                                                                                                   |
| 5.- USOS AMBIENTALES                                                                    |                              |                  |                          |                   |                                                                                                                                   |
| CALIDAD 5.1<br>a) Recarga de acuíferos por percolación localizada a través del terreno. | No se fija límite            | 1.000 UFC/100 mL | 35 mg/L                  | No se fija límite | N <sub>T</sub> <sup>-1</sup> 10 mg N/L<br>NO <sub>3</sub> <sup>-</sup> 25 mg NO <sub>3</sub> /L<br>Art. 257 a 259 del RD 849/1986 |
| CALIDAD 5.2<br>a) Recarga de acuíferos por inyección directa                            | 1<br>huevo/10 L              | 0<br>UFC/100 mL  | 10 mg/L                  | 2 UNT             |                                                                                                                                   |

## Infiltration Water Quality (RD 1620/2007)



# TECHNIQUES CLASSIFICATION

- Detention - Retention
  - D-DIP** detention tanks
  - D-PAR** detention parterres
  - R-ALJ** cistern
- Filtration
  - F-FRA** filter strips
  - F-RAS** trench filters
  - F-COB** green-roofs
- Infiltration
  - I-POU** / **I-DIP** infiltration tanks
  - I-PAV** permeable pavements
  - I-PAR** water parterres
  - I-ESC** infiltration tree grills
- Treatment
  - T-BIO** bio-retention strips
  - T-EST** infiltration ponds
  - T-CUN** green ditches



**I-PAR** La Marina del Prat Vermell



**I-DIP** Bon Pastor

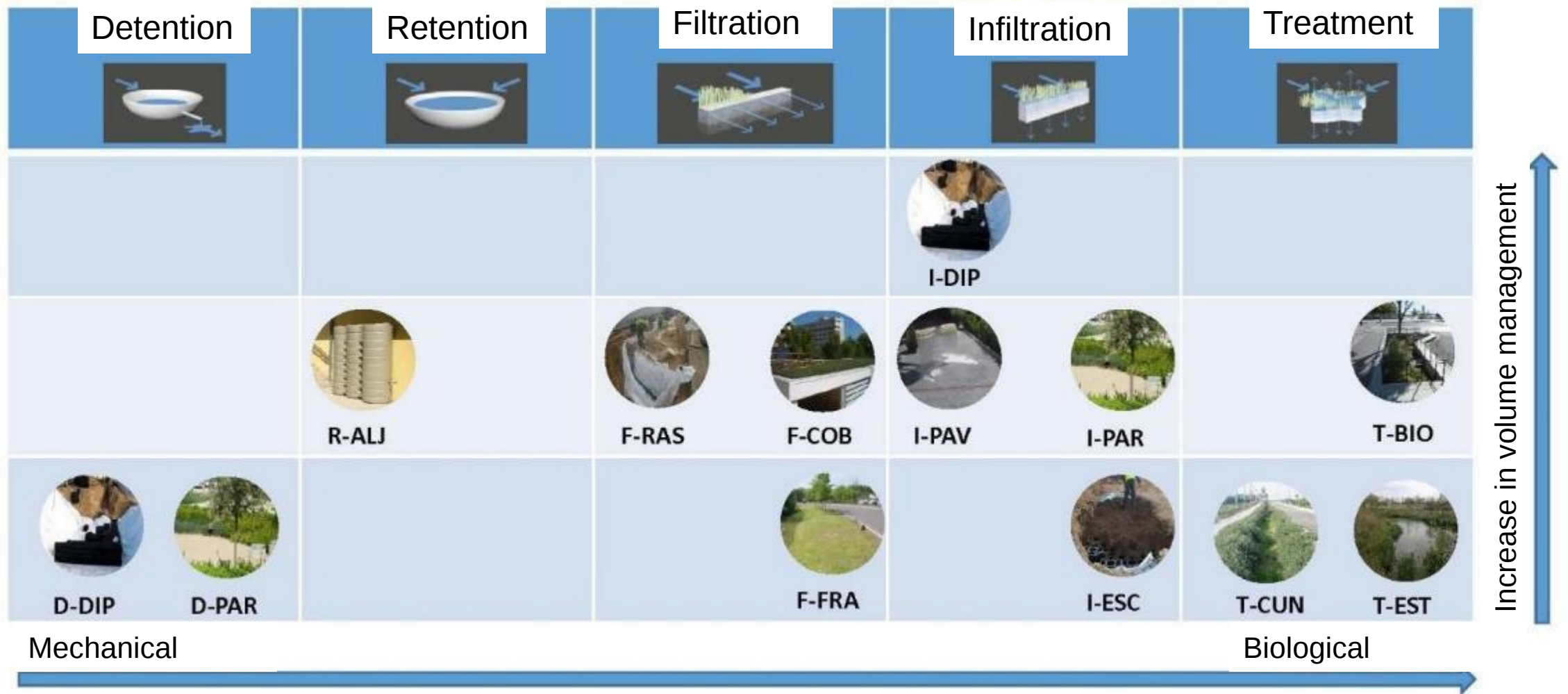
**D-DIP   R-ALJ   F-RAS   F-FRA   F-COB   I-PAV   I-DIP   I-ESC   I-PAR   T-CUN   T-EST   T-BIO**

Les aigües pluvials provinents de la xarxa separativa dels edificis de nova construcció i de la major part de la superfície de voreres, espais de vianants i vials, es dirigeixen cap a parterres inundables on l'aigua s'evacuarà per processos d'infiltració al terreny, evaporació i evapotranspiració. Sols en casos de pluges significatives es produirà un sobreeximent cap a la xarxa de clavegueram. A més a més s'han utilitzat altres tipus de SUDS, com franges de biorretenció i escocells d'infiltració al carrer de Biosca. S'aprofita la permeabilitat del terreny del barri de Bon Pastor per donar continuïtat a la xarxa separativa d'evacuació d'aigües residuals i pluvials imposada pel Codi Tècnic de l'Edificació i a l'hora contribuir al bon funcionament del sistema de sanejament i drenatge de la ciutat.

Soto-Fernández (2013 i 2016).

Diagrama de un sistema de riego por goteo en un terreno urbano. El sistema incluye un pozo de captación que alimenta un sistema de tuberías con emisores que riegan una zona verde. Se indican también las zonas de captación y las zonas de riego.

# FUNCTIONS VS. TECHNIQUES



## MULTI-CRITERIA EVALUTION

| SUDS TECHNIQUES |                                | Peak flow<br>reduction | Runoff volume<br>reduction |                   | Water quality<br>improvement | Health and<br>citizen<br>welfare<br>benefits | Biodiversity,<br>Urban<br>Ecosystem<br>benefits | Construction<br>cost | Maintenance<br>cost |
|-----------------|--------------------------------|------------------------|----------------------------|-------------------|------------------------------|----------------------------------------------|-------------------------------------------------|----------------------|---------------------|
|                 |                                |                        | Frequent<br>events         | Extreme<br>events |                              |                                              |                                                 |                      |                     |
| Detention       | D-DIP detention tanks          | ++                     | ++                         |                   | ++                           | +                                            |                                                 | LOW                  | LOW                 |
|                 | D-PAR detention parterres      | ++                     | ++                         |                   | ++                           | ++                                           | ++                                              | LOW                  | LOW                 |
|                 | R-ALJ cisterns                 | +                      | ++                         | +                 |                              | ++                                           |                                                 | LOW                  | LOW/MEDIUM          |
| Filtration      | F-FRA filter strips            |                        | ++                         |                   | ++                           | +                                            | +                                               | LOW                  | LOW/MEDIUM          |
|                 | F-RAS trench filters           | +                      | ++                         |                   | ++                           | +                                            | +                                               | LOW                  | MEDIUM              |
|                 | F-COB green-roofs              | +                      | ++                         |                   | ++                           | ++                                           | ++                                              | Alt                  | MEDIUM/HIGH         |
| Infiltration    | I-POU infiltration wells       | ++                     | ++                         | ++                | ++                           | +                                            | +                                               | LOW                  | MEDIUM              |
|                 | I-DIP infiltration tanks       | ++                     | ++                         | ++                | ++                           | +                                            | +                                               | HIGH                 | MEDIUM              |
|                 | I-PAV permeable pavements      | ++                     | ++                         | ++                | ++                           | +                                            | +                                               | HIGH                 | MEDIUM              |
|                 | I-PAR water parterres          | ++                     | ++                         | ++                | ++                           | ++                                           | ++                                              | MEDIUM               | MEDIUM              |
|                 | I-ESC infiltration tree grills | +                      | ++                         |                   | ++                           | +                                            | ++                                              | MEDIUM               | MEDIUM              |
| Treatment       | T-BIO bio-retention strips     | ++                     | ++                         | ++                | ++                           | ++                                           | ++                                              | MEDIUM               | MEDIUM              |
|                 | T-EST infiltration ponds       | ++                     |                            |                   | ++                           | ++                                           | ++                                              | LOW                  | LOW                 |
|                 | T-CUN green ditches            | ++                     | ++                         | +                 | ++                           | ++                                           | ++                                              | LOW                  | LOW                 |

++ Achievement of the likely objective

+ Possible objective compliance, if specially designed

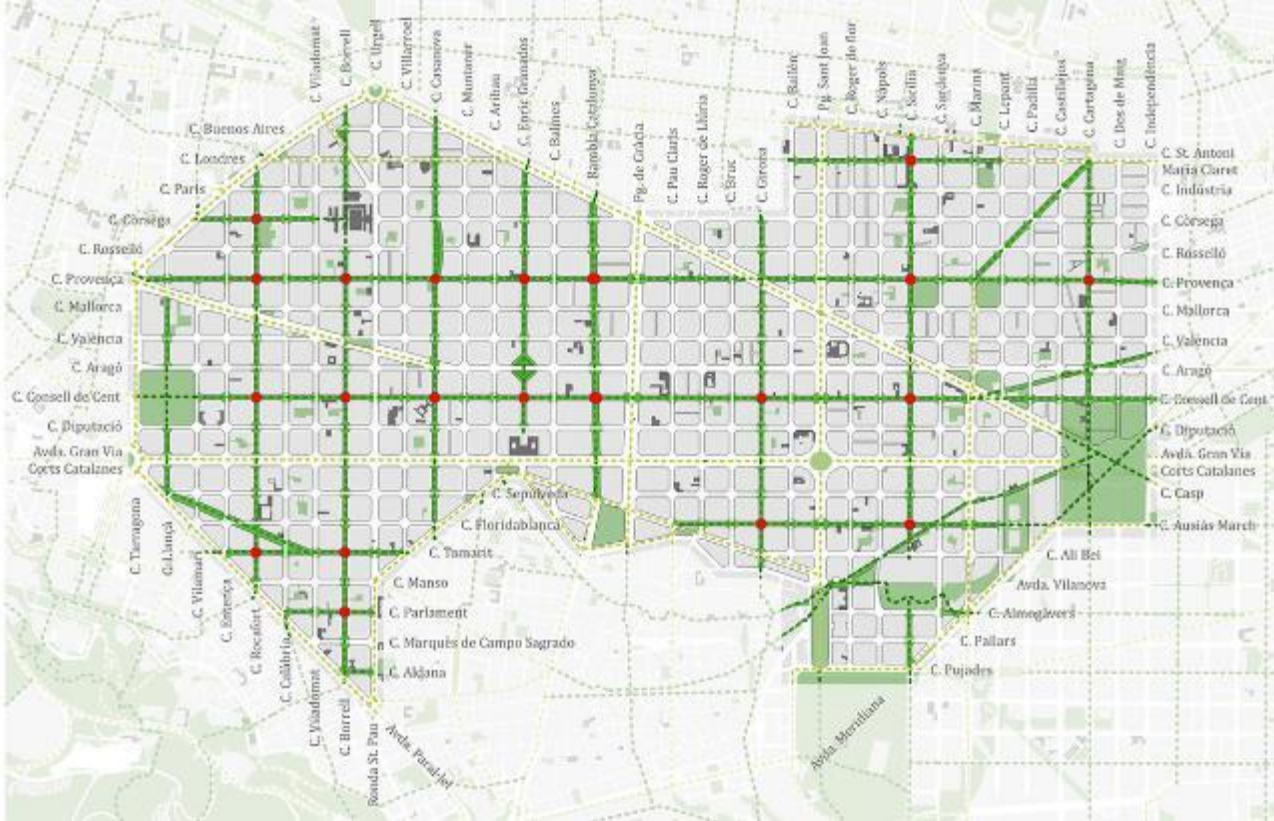
Cost-benefit assessment: SOCIAL, ENVIRONMENT AND ECONOMIC





# BARCELONA SUPERBLOCKS: NEW STAGE AT EIXAMPLE DISTRICT

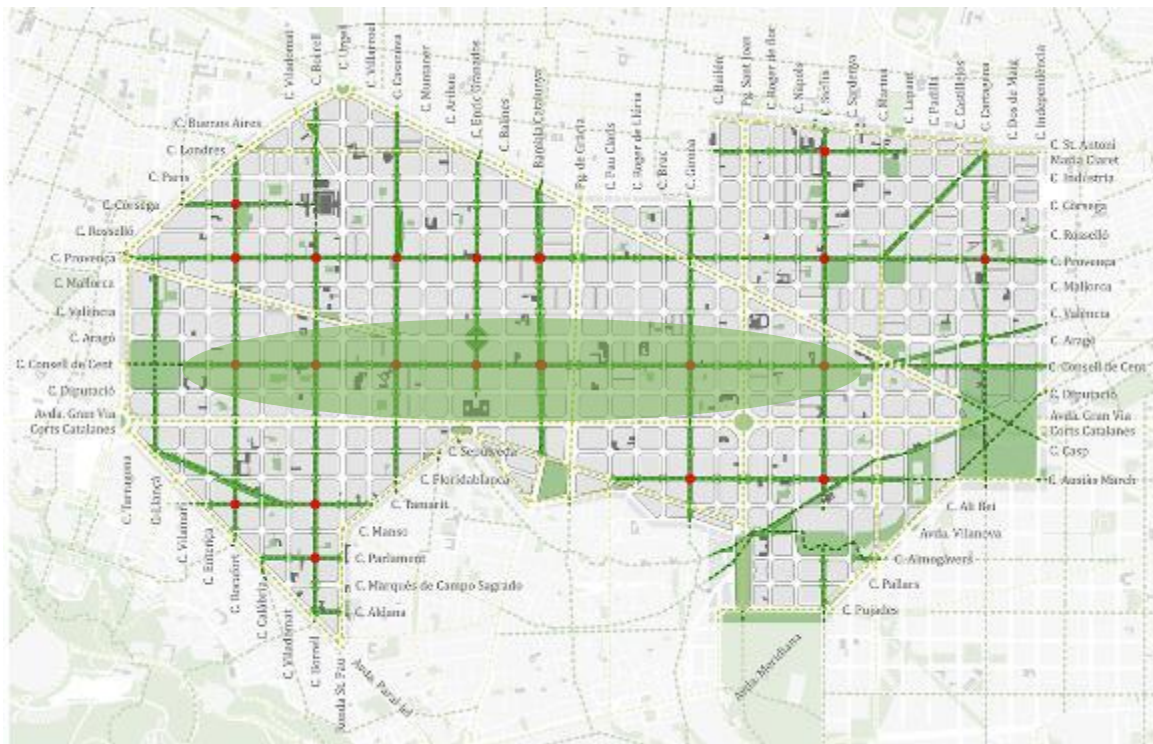
Over the next decade, Barcelona will convert its entire central grid into a **greener, pedestrian-friendly area almost totally cleared of cars.**



This new stage will make it possible to extend the super-blocks transformation to the entire **Eixample district**, a priority area of action with the potential for a huge impact on the rest of the city due to its population density, volume of traffic, high pollution level and the need for more pleasant green spaces.

So, 21 green axes will emerge, representing 33 km; with 21 new squares, adding 3.9 hectares of new public space. Eixample will gain 33.4 hectares of new pedestrian priority space and 6.6 ha of green space.

## FIRST STEPS THIS TERM OF OFFICE



Revamps to be executed until 2023 include 4 new green axes and 4 new green squares with **an investment of 37.8 M€** during this term of office.



### Forthcoming green axes:

- 1 Consell de Cent
- 2 Girona
- 3 Rocafort
- 4 Borrell

**TOTAL: 4,65 km , superfície 11,12 Ha**

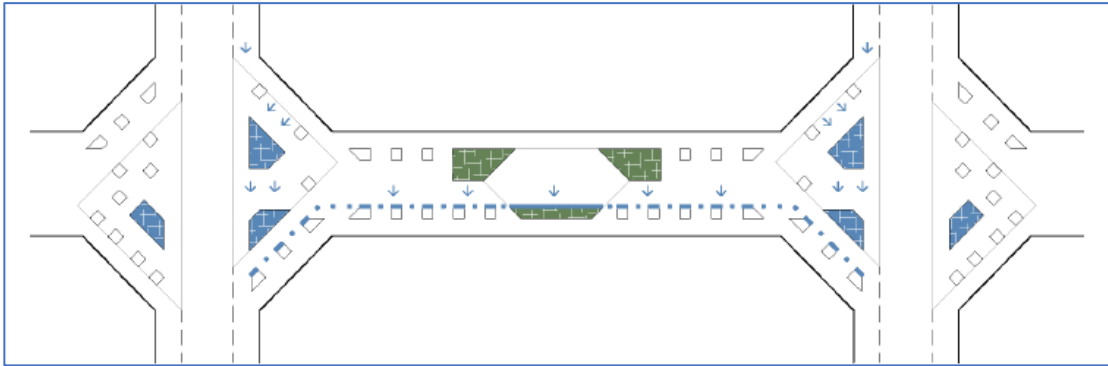
### Forthcoming green squares:

1. Consell de Cent – Rocafort
2. Consell de Cent – Borrell
3. Consell de Cent - Enric Granados
4. Consell de Cent – Girona

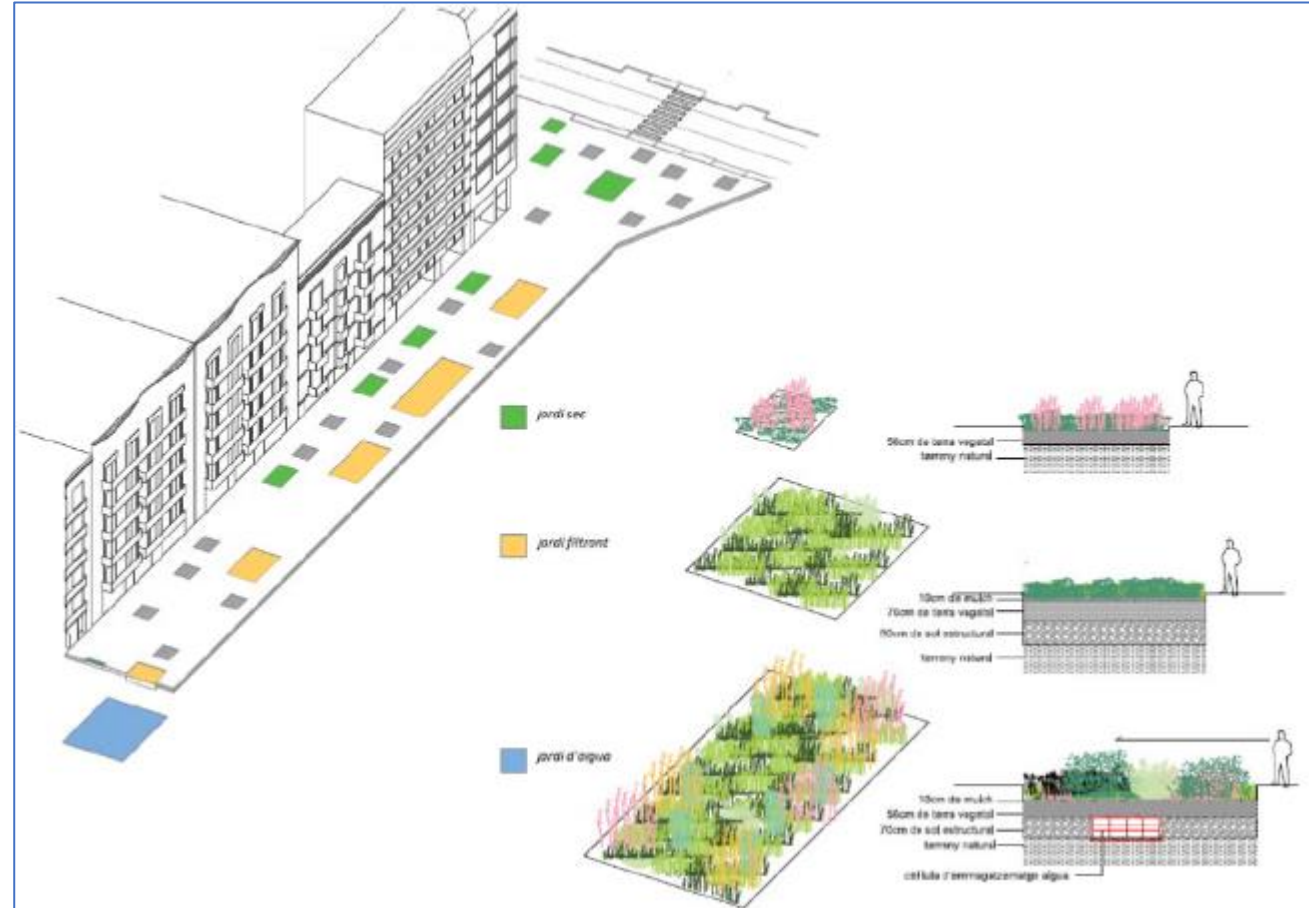
**TOTAL: 0,8 Ha (aprox)**

## URBAN WATER CYCLE AT EIXAMPLE SUPERBLOCKS

Regarding the water cycle, the proposals presented so far in the basic projects mostly include actions related to Action Line 6 of the PLARHAB - **Rainwater harvesting through SUDS (Sustainable Urban Drainage Systems)**, although AL1. Groundwater use for irrigation and AL4. Use of rainwater from the roofs of public buildings to infiltrate through SUDS are also under consideration.



SUDS proposal for each stretch of Consell de Cent street: Infiltration green spaces in demi-squares and around living areas.



SUDS proposal for Comte Borrel street: bio-retention areas and infiltration tanks below ground.

## 21st-century streets



**New  
environment  
infrastructure**

**Proximity  
Play and well-  
being areas**

**New materiality**

**Continuities  
Water sensitive  
design**

**Accessibility**

## Discover more about Barcelona strategy:

Barcelona Climate Emergency Declaration <https://www.barcelona.cat/emergenciaclimatica/en>

Barcelona Nature Plan 2021 – 2030 [https://www.barcelona.cat/infobarcelona/en/the-new-nature-plan-seeks-to-create-an-extra-18-6-hectares-of-greenery-by-2023-2\\_1062474.html](https://www.barcelona.cat/infobarcelona/en/the-new-nature-plan-seeks-to-create-an-extra-18-6-hectares-of-greenery-by-2023-2_1062474.html)

Sanitation Master Plan PIDSBA - <https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/119275>

Alternative Water Resources Master Plan - <https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/121227>

Barcelona drought protocol 2018 <https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/109314>

SUDS Technical Manual. BCNSUDS Commission [https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/PlecPrescripcionsTechniquesDrenatge\\_Guia.pdf](https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/PlecPrescripcionsTechniquesDrenatge_Guia.pdf)

Barcelona Superblock – Superilla <https://ajuntament.barcelona.cat/superilles/en/>

Climate Shelters in schools <https://www.barcelona.cat/barcelona-pel-clima/en/climate-shelters-schools>

# THANK YOU VERY MUCH FOR YOU ATTENTION!

## Barcelona Water Cycle

Carrer Acer, 16

08038 Barcelona

Tel: +34 93 289 68 00

<http://ajuntament.barcelona.cat/ecologiaurbana/en>  
[info.bcasa@bcn.cat](mailto:info.bcasa@bcn.cat)

Contact:

Maria José Chesa Marro [mjchesam@bcn.cat](mailto:mjchesam@bcn.cat)

Head Environment and External Relations Service. BCASA



Ajuntament  
de Barcelona