Barcelona SUDS STRATEGY

MERLIN PROJECT

25 April 2024



Ajuntament de Barcelona | Barcelona Cicle de l'Aigua SA

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BARCELONA WATER CYCLE

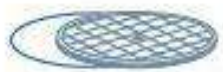
Barcelona Water Cycle (BCASA) is a municipal 100% public company incorporated in 2014 and integrated into the Area of Ecology, Urban Planning and Mobility at Barcelona City Council.

Its purpose is to manage the city's entire water cycle and provide services directly and indirectly relating to that cycle and the city's beaches, coast and urban environment.

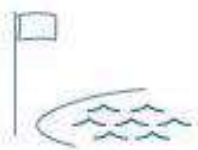
BCASA provides services centered on the Comprehensive Water Cycle and operates in four strategic areas: supply, urban drainage and sewerage system, coastal management and other support initiatives in the cycle, serving 1.6 million city residents and over 9 million visitors a year.



Groundwater provision



Urban drainage and the sewer network



Coastline management



Other services



Public Water Operators Network

Aqua pública europea

aeopas

AMAP
Associació de Municipis i Entitats per l'Aigua Pública

Collaborations

GWOPA

UN-HABITAT
FOR A BETTER URBAN FUTURE

Aigua és vida

Enginyeria Sense Fronteres

Water cluster

CWP
CATALAN WATER PARTNERSHIP

European projects

ECHORD

Urban robots for sewer maintenance

RESCCUE

Urban Water Resilience

ENFORCE
Citizen science & water management

iBathwater

Urban bathing waters management

scorewater

Sewer sociology
Waste

REFUGIS CLIMÀTICS

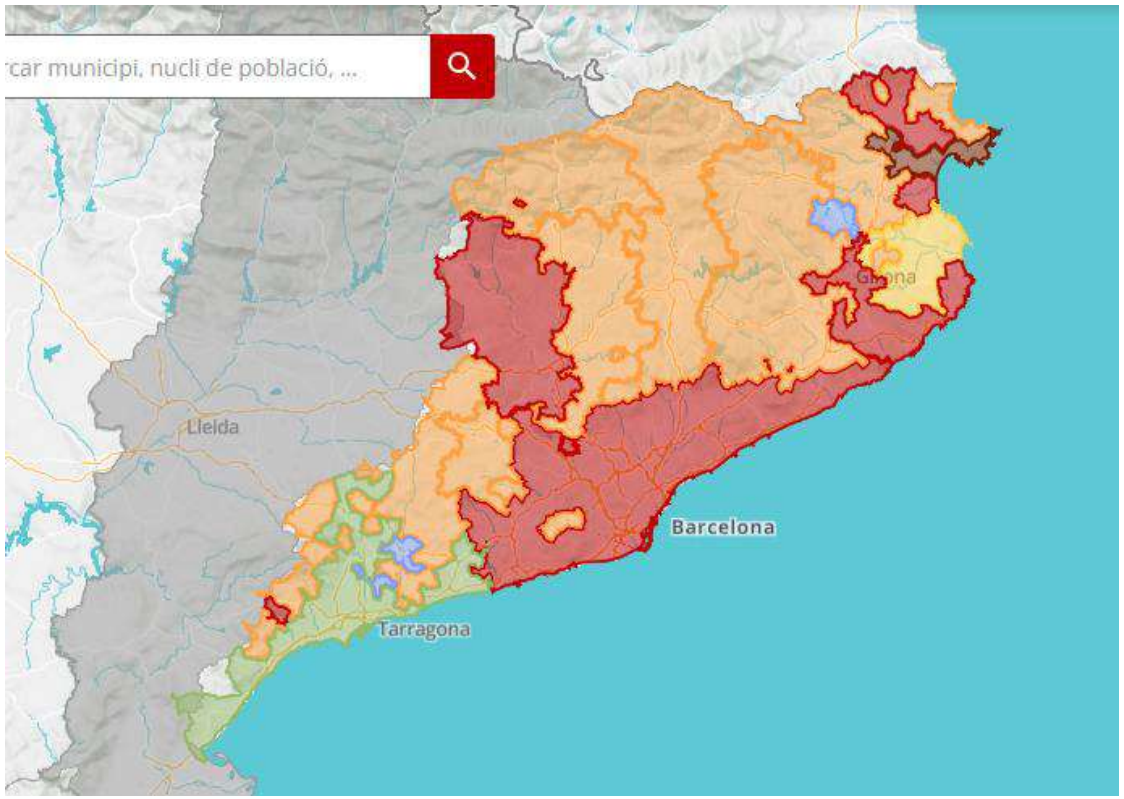
Climate shelters
Blue solutions

DROUGHTS THROUGH HISTORY IN BARCELONA METROPOLITAN AREA

- **Mediterranean climate**: **No rain** periods vs. **torrential rains**.
- Particularly **vulnerable** to suffering episodes of **drought** and **flooding**.
- Population is concentrated where **water** from rivers o groundwater **is not available**.

Throughout recent history, Catalonia has suffered several episodes of moderate to severe droughts.

- Between **1944** and **1950** → restrictions on the supply to various populations and during different periods.
- In **1953** it only rained half of what was normal → in mid-May there were cuts in water supply to homes for 30% of the hours of the day.
- In **2008** Catalonia suffered several episodes of severe drought that caused major restrictions on supply and cuts were about to affect the capital until it rained.
- **2021, 2022, 2023, 2024** have been one of the driest periods for which data is available.

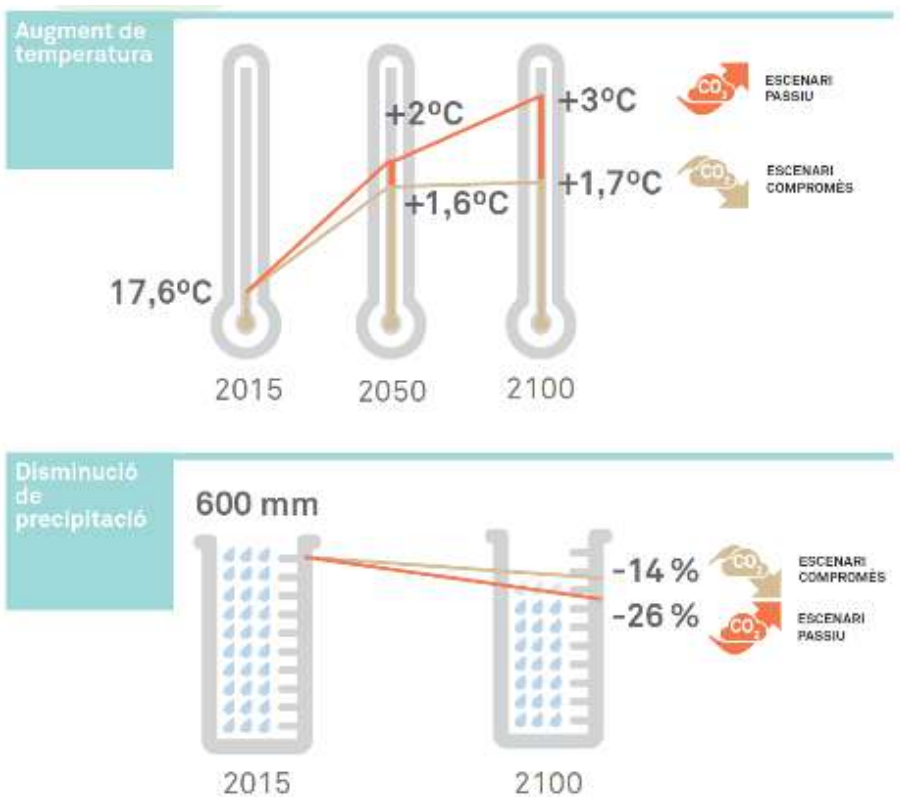


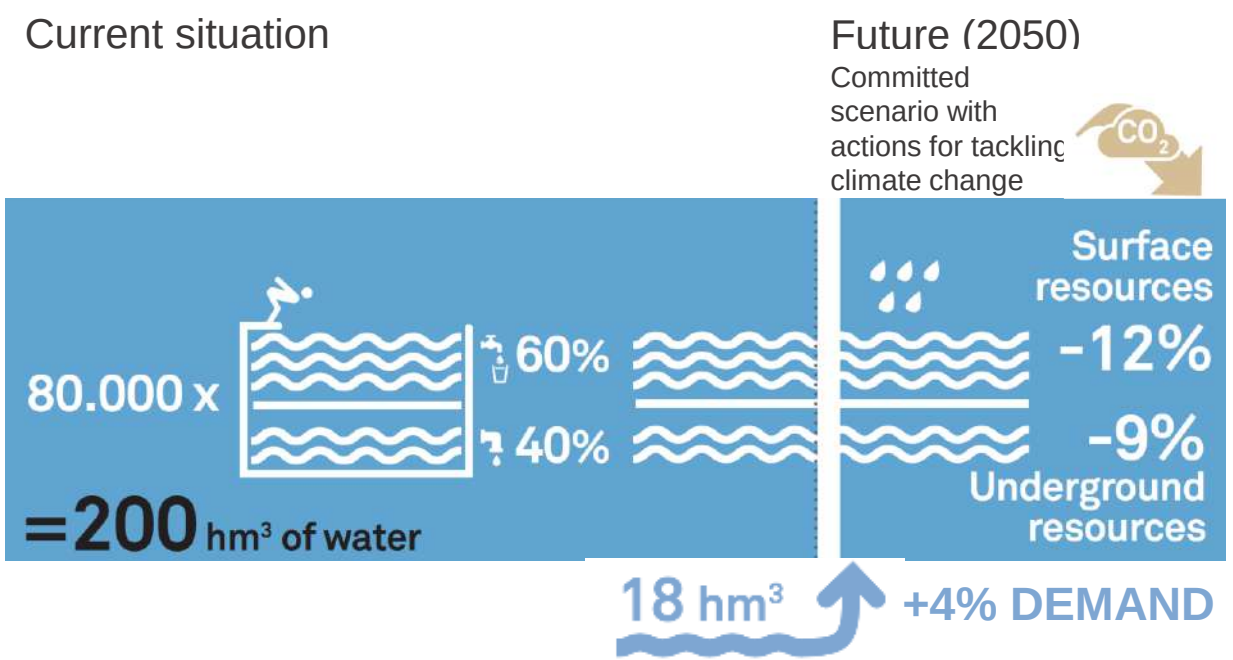
Source: https://aplicacions.aca.gencat.cat/visseq/estat-actual 25/04/2024

FORECASTS FOR WATER NEEDS AND AVAILABILITY IN BARCELONA CITY (1.62 MILLION INHABITANTS)

+ Frequency of dry periods and tendency towards the reduction of the annual average precipitation

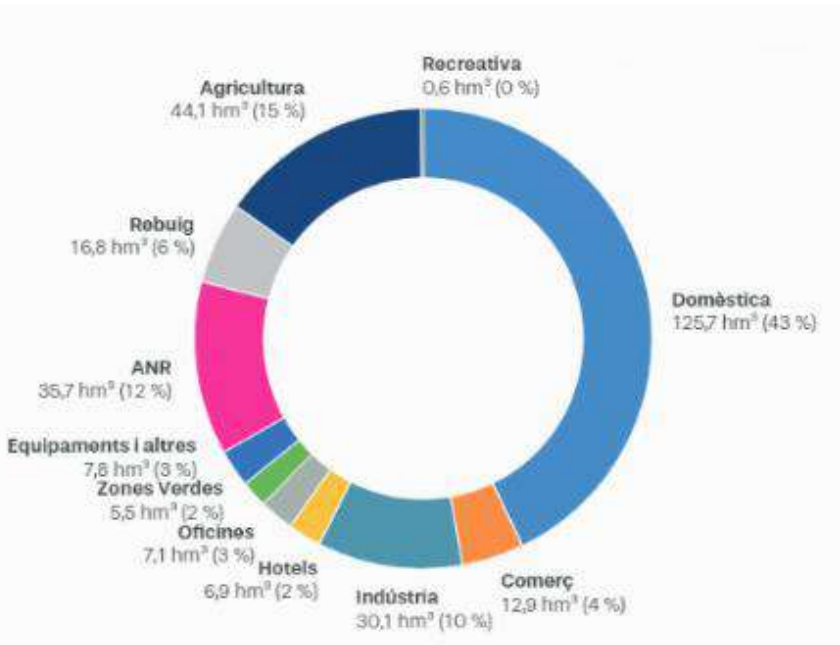
+ Intensity of rains and concentration of extreme episodes





FORECASTS FOR WATER NEEDS IN BARCELONA METROPOLITAN AREA (5.3 MILLION INHABITANTS)

2019

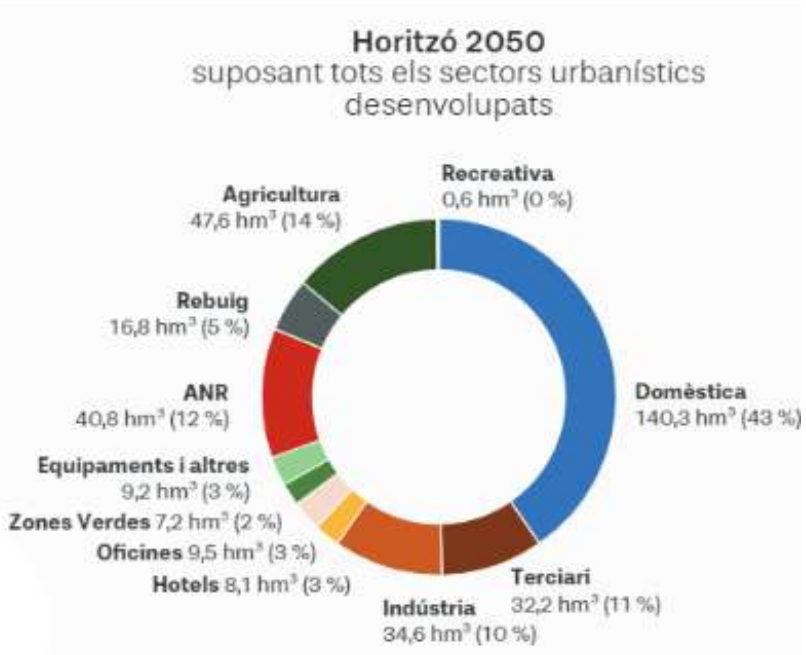


293 hm3

Total water consumption (all sources)

Source: https://www.pecia.cat/

2050

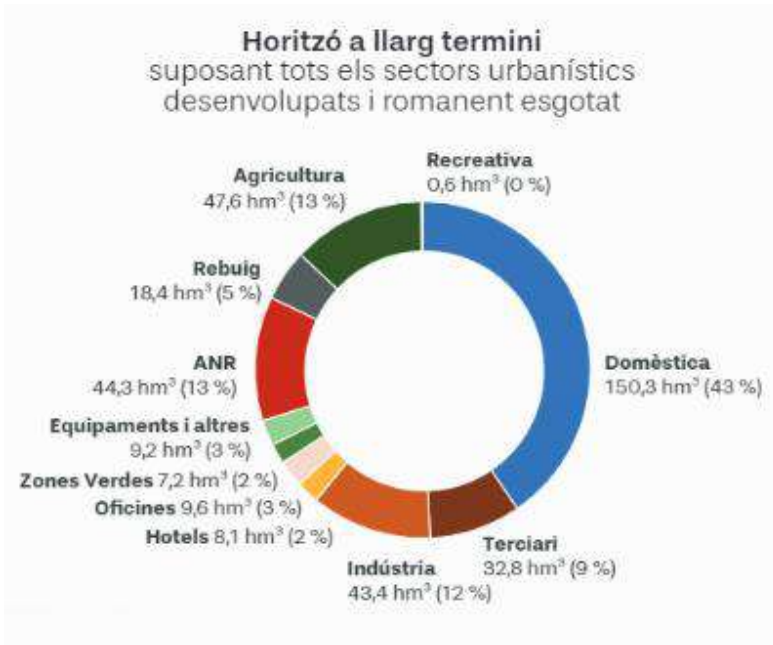


329 hm3

(-36 hm3)

Estimation of total water consumption including urban development plans in progress

2100



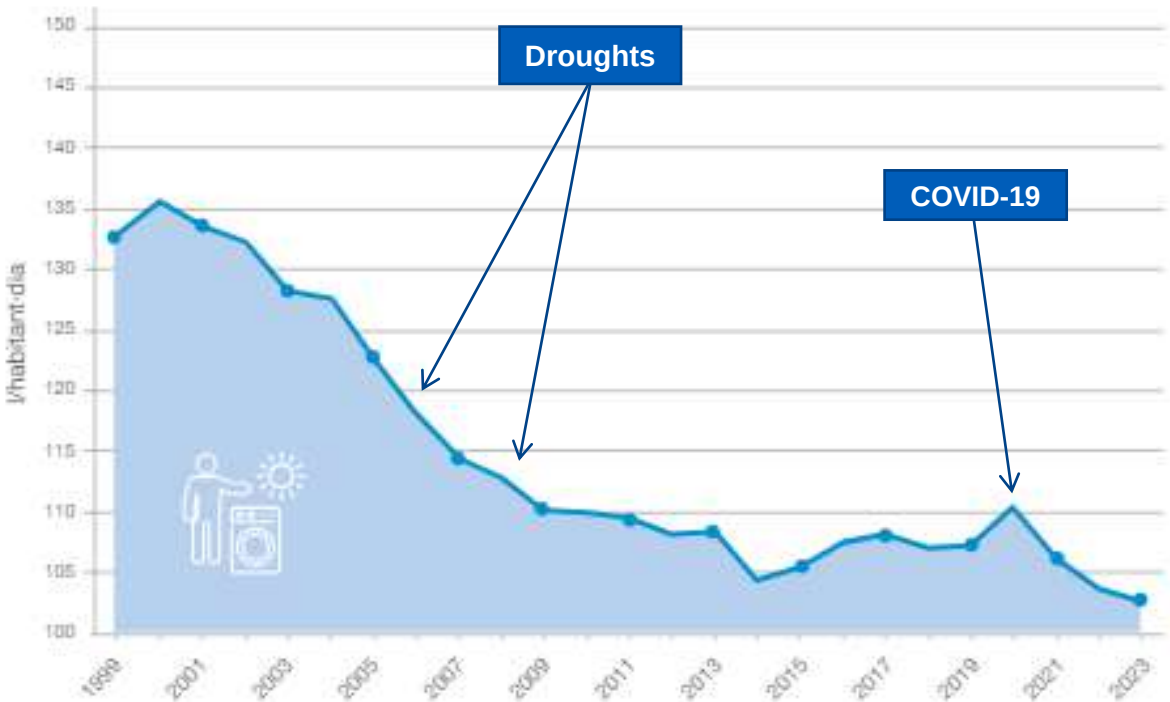
354 hm3

(-61 hm3)

Estimation of total water consumption Including a total urban development

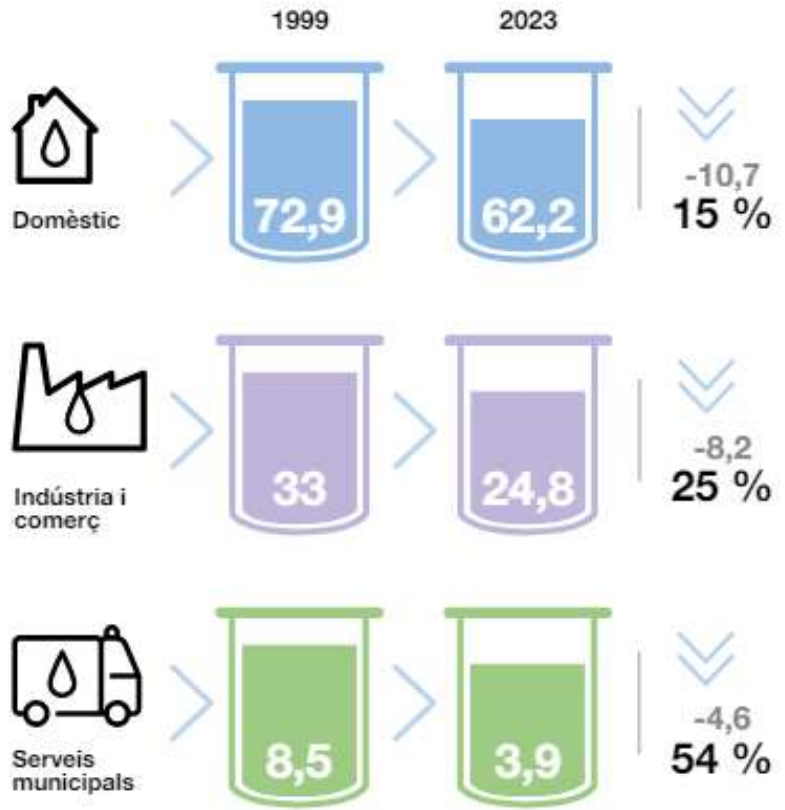
EVOLUTION OF WATER CONSUMPTION IN BARCELONA. SOBRIETY AND SOLIDARITY.

Domestic consumption of drinking water (l / inhab. & day)



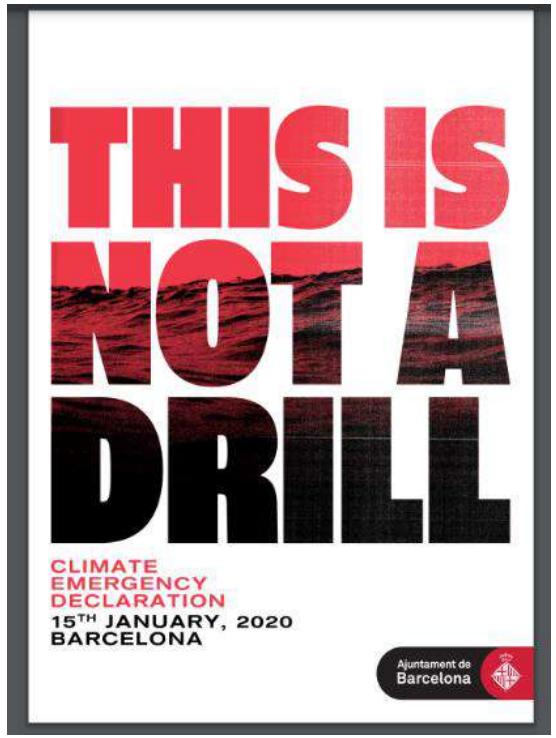
98,7 **liter/equivalent inhab./day**

Drinking water consumption by sectors (hm3)



Population	**1.503.451 inhab.**	**1.660.122 inhhab**	**+ 9,44 %**


PLA
CLIMA


THIS IS
NOT A
DRILL
CLIMATE
EMERGENCY
DECLARATION
15TH JANUARY, 2020
BARCELONA
Ajuntament de
Barcelona


PLA
LITORAL
Pla estratègic dels espais
litorals de la ciutat


PLARHAB 2020
Pla tècnic per a l'aprofitament de recursos hídrics alternatius de Barcelona


Pla Director Integral
de Sanejament de la ciutat
de Barcelona (PDISBA)
Memòria


AMB
Àrea Metropolitana
de Barcelona
Pla Estratègic
del Cicle Integral
de l'Aigua
Pla estratègic
del cicle integral de l'aigua
Una visió metropolitana pel 2050

PLARHAB – ALTERNATIVE WATER RESOURCES MASTERPLAN

LA.1 GROUNDWATER

LA.2 REGENERATED

LA.3 GREYWATER

LA.4 RAINFALL ON ROOFS

LA.5 RAINFALL ON MOUNTAINS/TORRENTS

LA.6 SUDS. SUSTAINABLE URBAN DRAINAGE

LA.7 DIRECT SEA WATER

EFFICIENCY AND SAVINGS

1. **The saving measures in parks and gardens:** consumption control and automatic reduction of leakage.
2. **The flow regulation in public and ornamental fountains:** Installation of switches and saving systems
3. **The reduction of tap water consumption for cleaning streets:** use of groundwater.
4. **Promoting water conservation in public buildings**
5. **Reduce the consumption with high efficiency equipment** with meter installation, detection and control of water leaks.
6. **Saving water in schools:** The City Council has promoted the implementation of savings measures in schools and the efficient use of water in the context of Agenda 21.
7. **Divulgation of advice and practical - Agenda 21:** awareness material to promote the economy and the responsible use of water between citizens and municipal actions: guides, brochures environmental education, websites and exhibitions







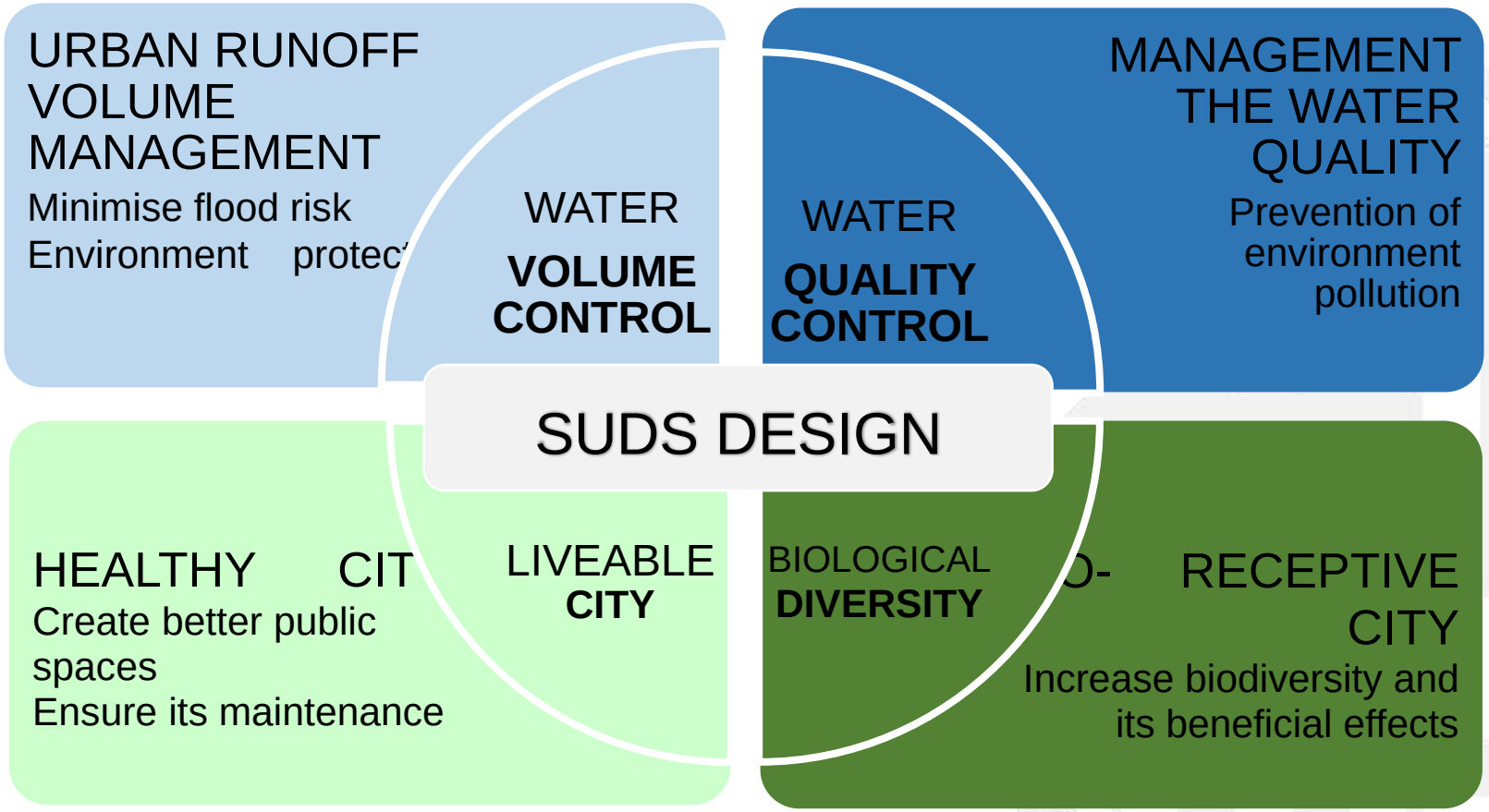

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WHAT ARE SUDS?

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



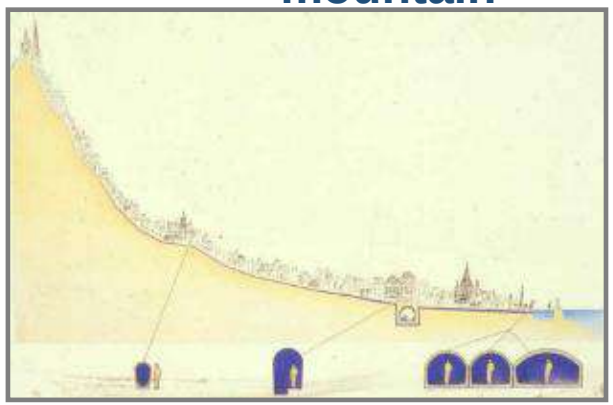
Own elaboration from The 4 pillars of SUDS Design (CIRIA, 2015)

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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^2

High land imperviousness





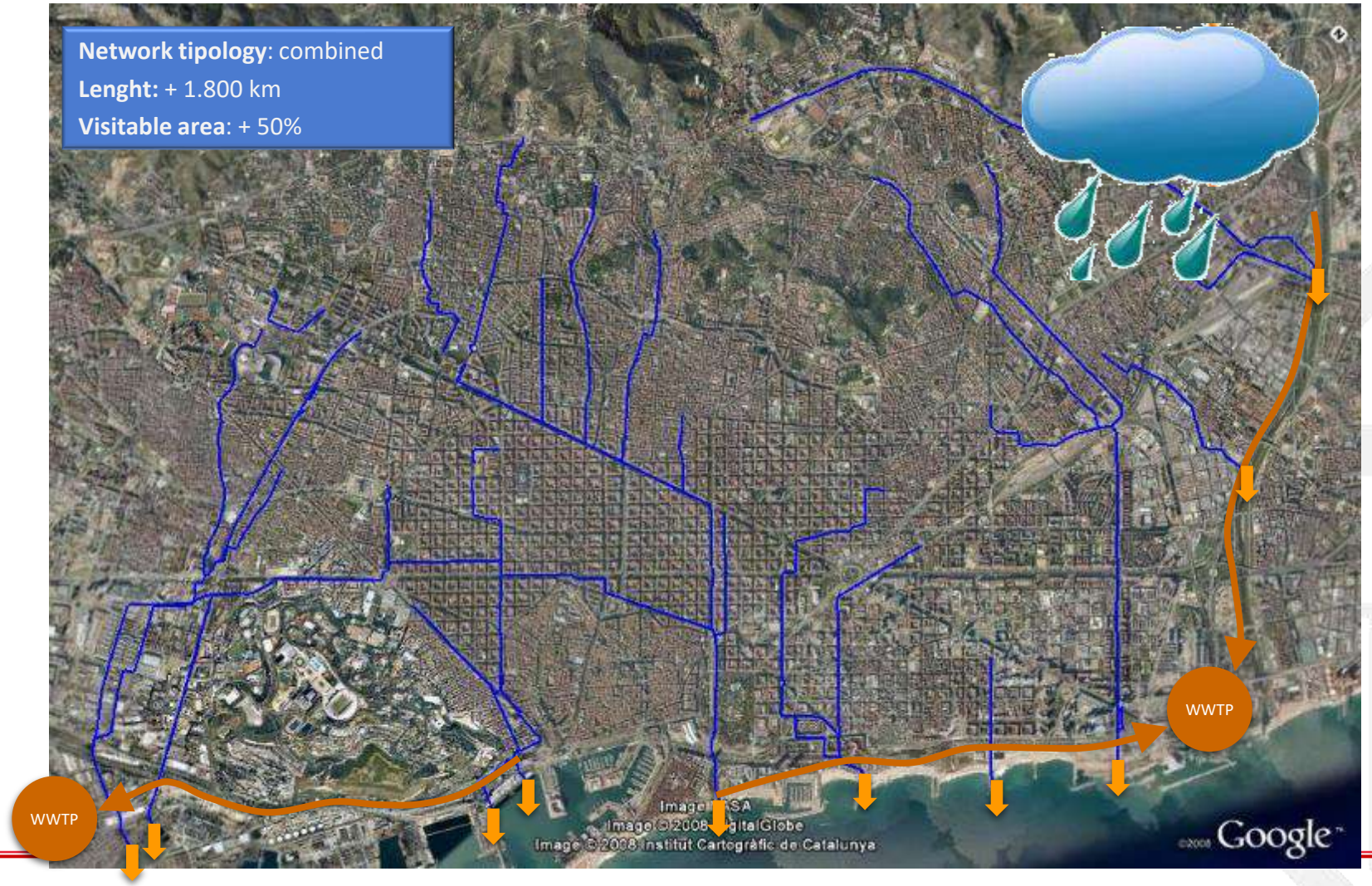




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WHY DO WE NEED SUDS?

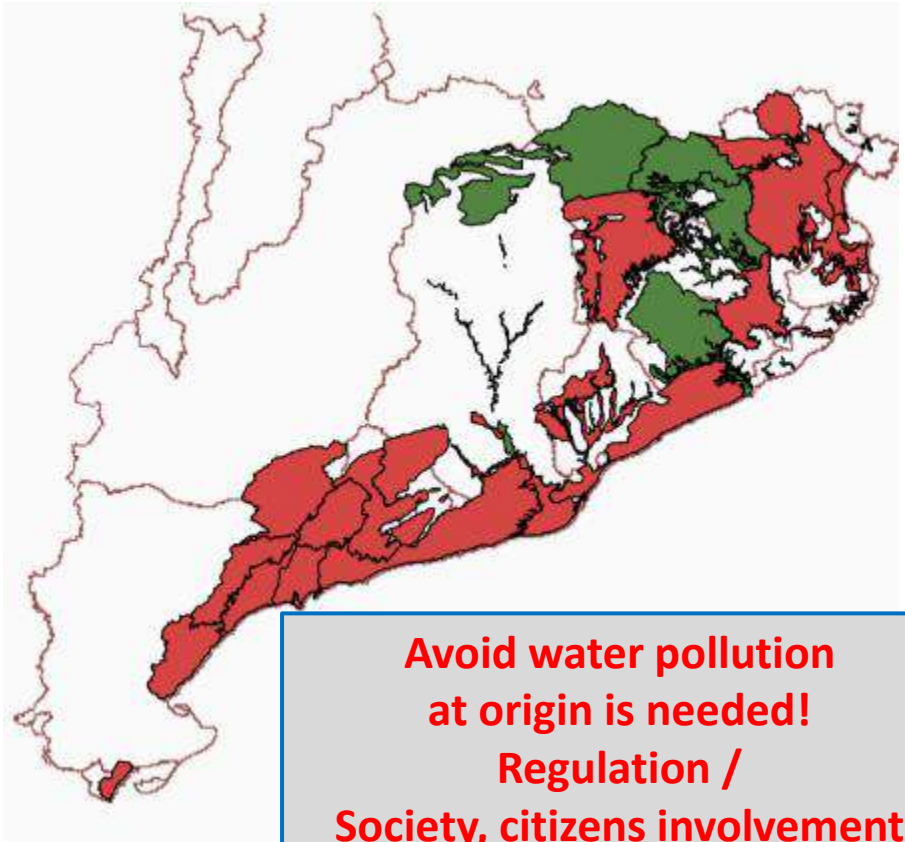
URBAN RUNOFF VOLUME MANAGEMENT – MINIMISE CSO

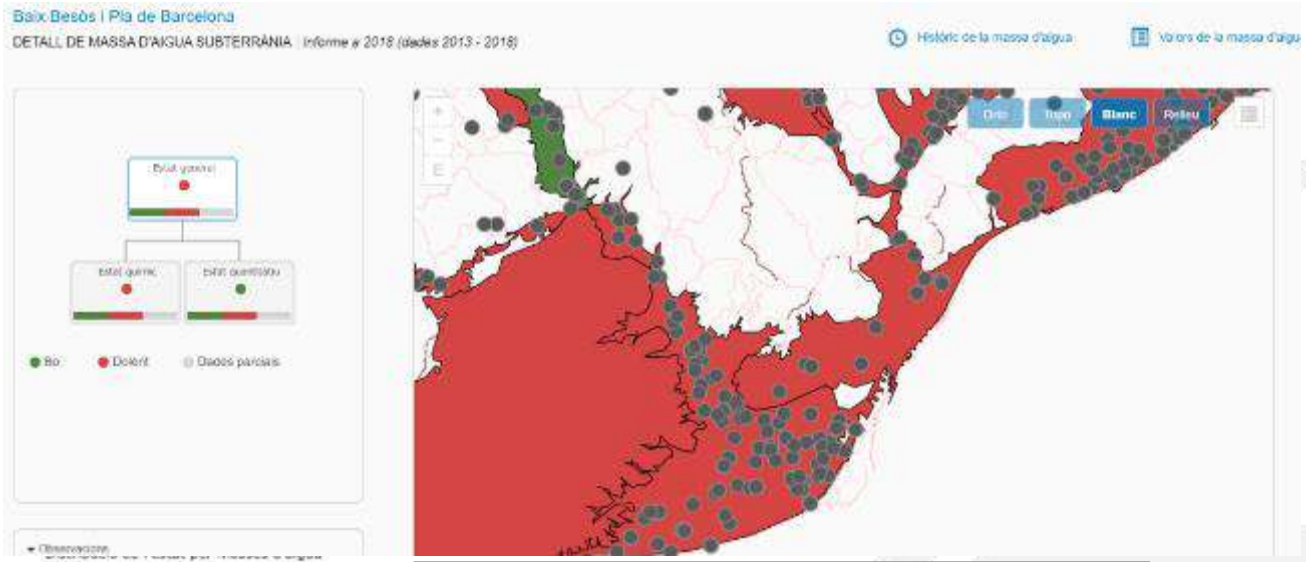


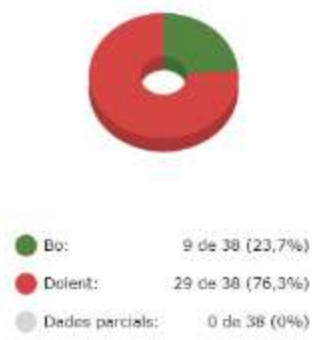
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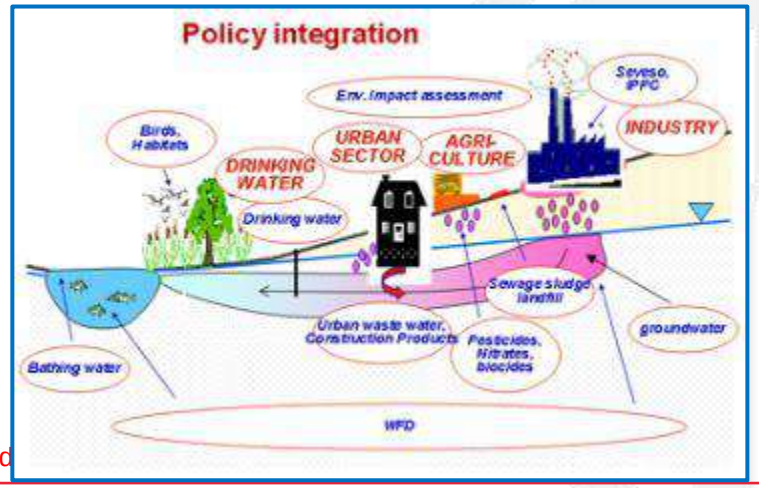
WHY DO WE NEED SUDS?

GROUNDWATER QUALITY – IMPROVE WATER BODIES STATUS









Avoid water pollution at origin is needed!
Regulation /
Society, citizens involvement

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

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WHY DO WE NEED SUDS?

LIVEABLE CITIES – HEALTH AND WELL-BEING



Parc de Joan Raventós

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WHY DO WE NEED SUDS?

BIORECEPTIVE CITIES – BENEFICIAL EFFECTS OF BIODIVERSITY



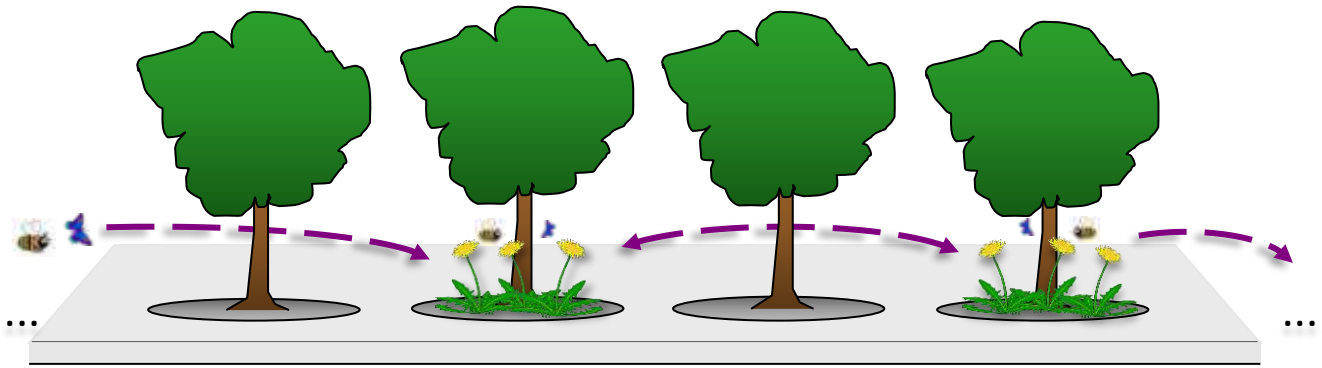
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BIORECEPTIVE CITIES – BENEFICIAL EFFECTS OF BIODIVERSITY

Designed ecology: Transforming gardens into flora and fauna habitats



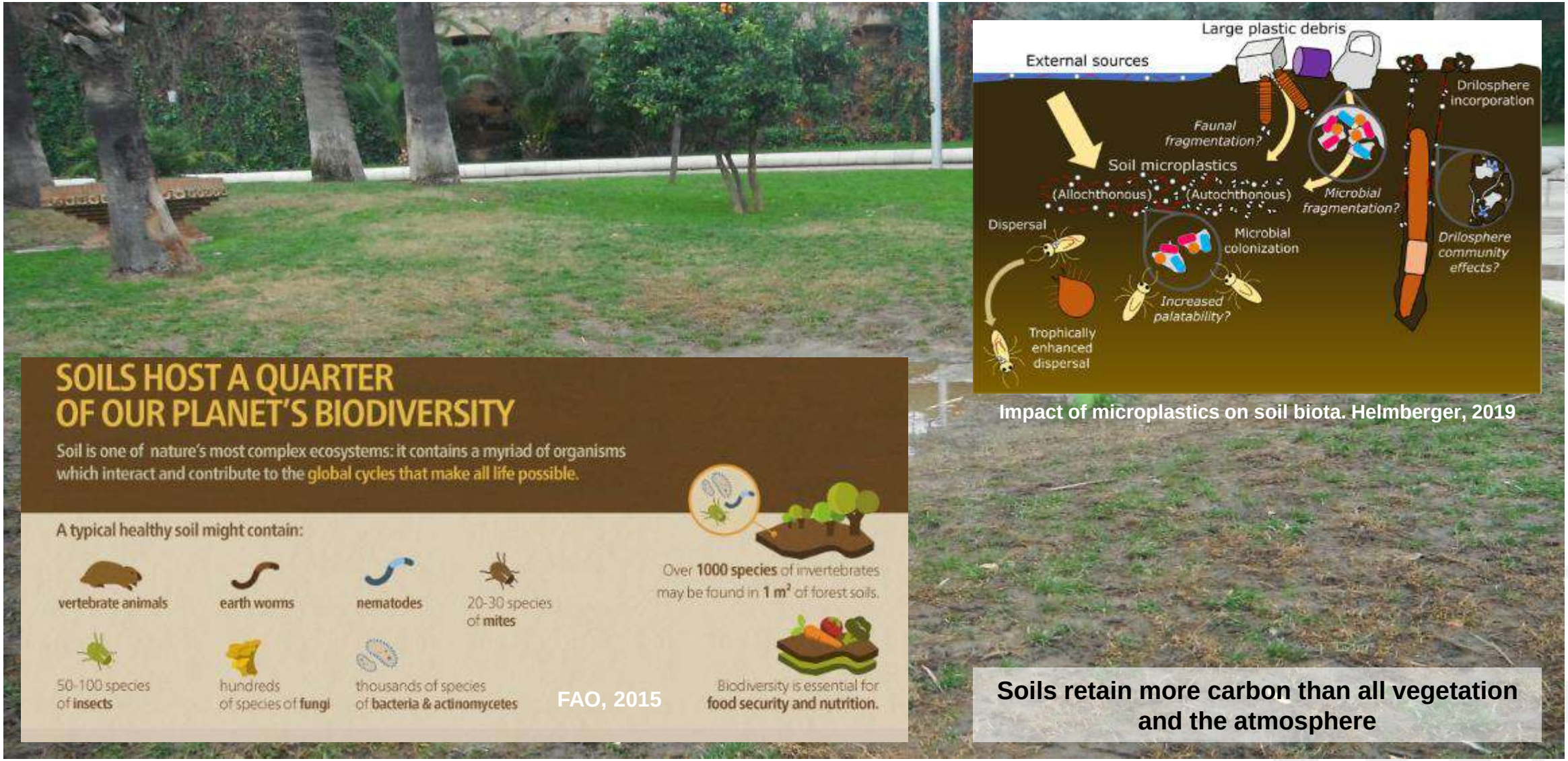
Carballo, G.; Escuer, L.; 2019



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 retain more carbon than all vegetation and the atmosphere

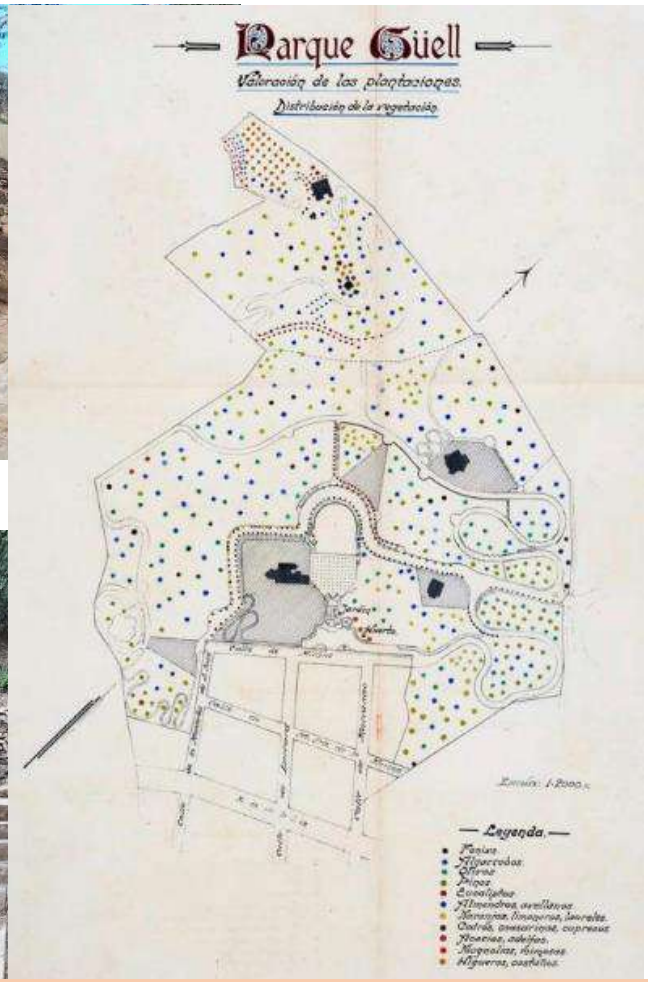
Ajuntament de Barcelona

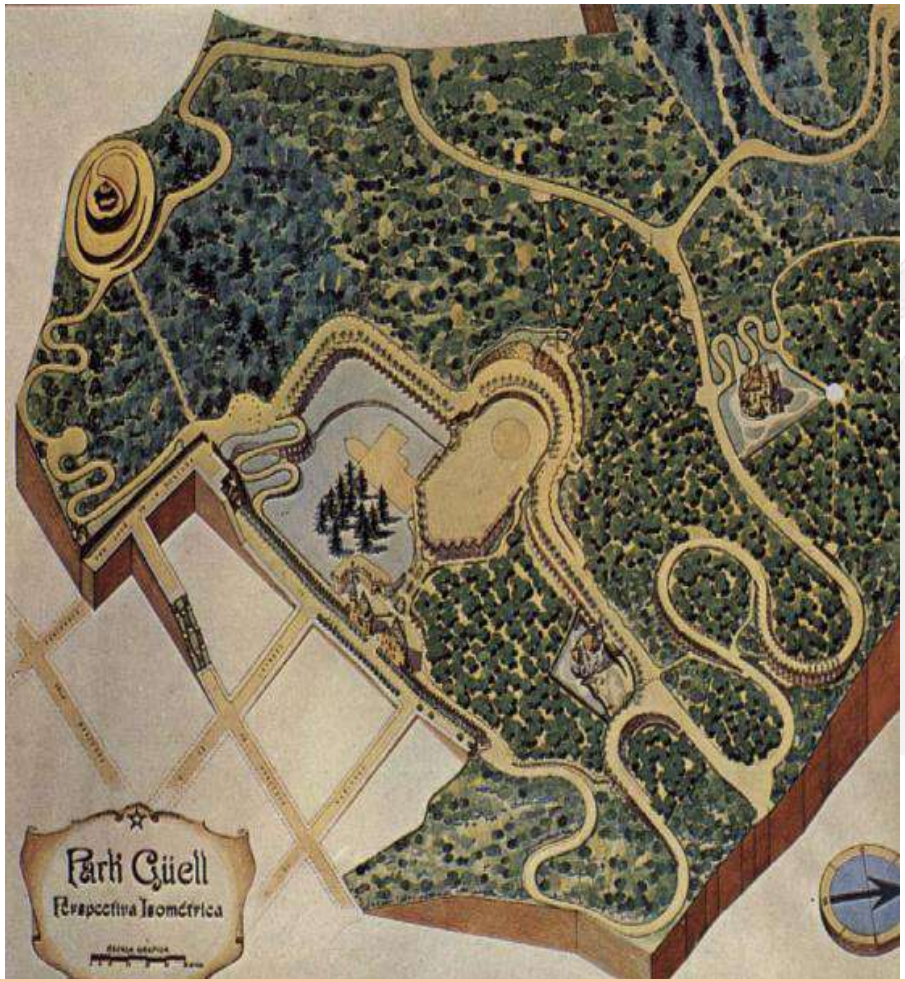
HOW DO WE MANAGE THE PARADIGM SHIFT?

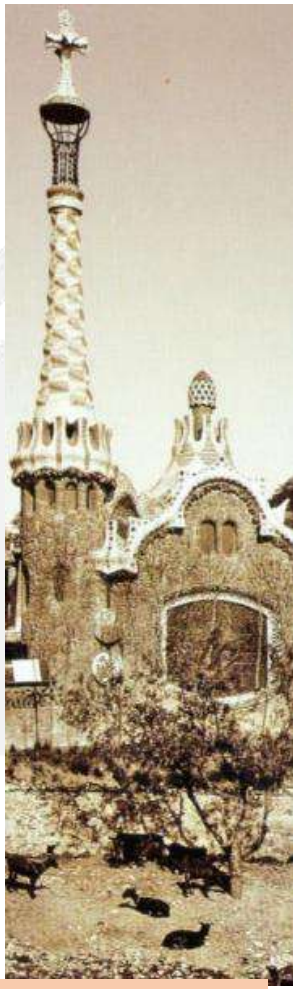
BUILDING ON NATURE, UNDERSTANDING WATER BEHAVIOUR, RECOVERING TRADITIONAL TECHNIQUES, REACHING AGREEMENT









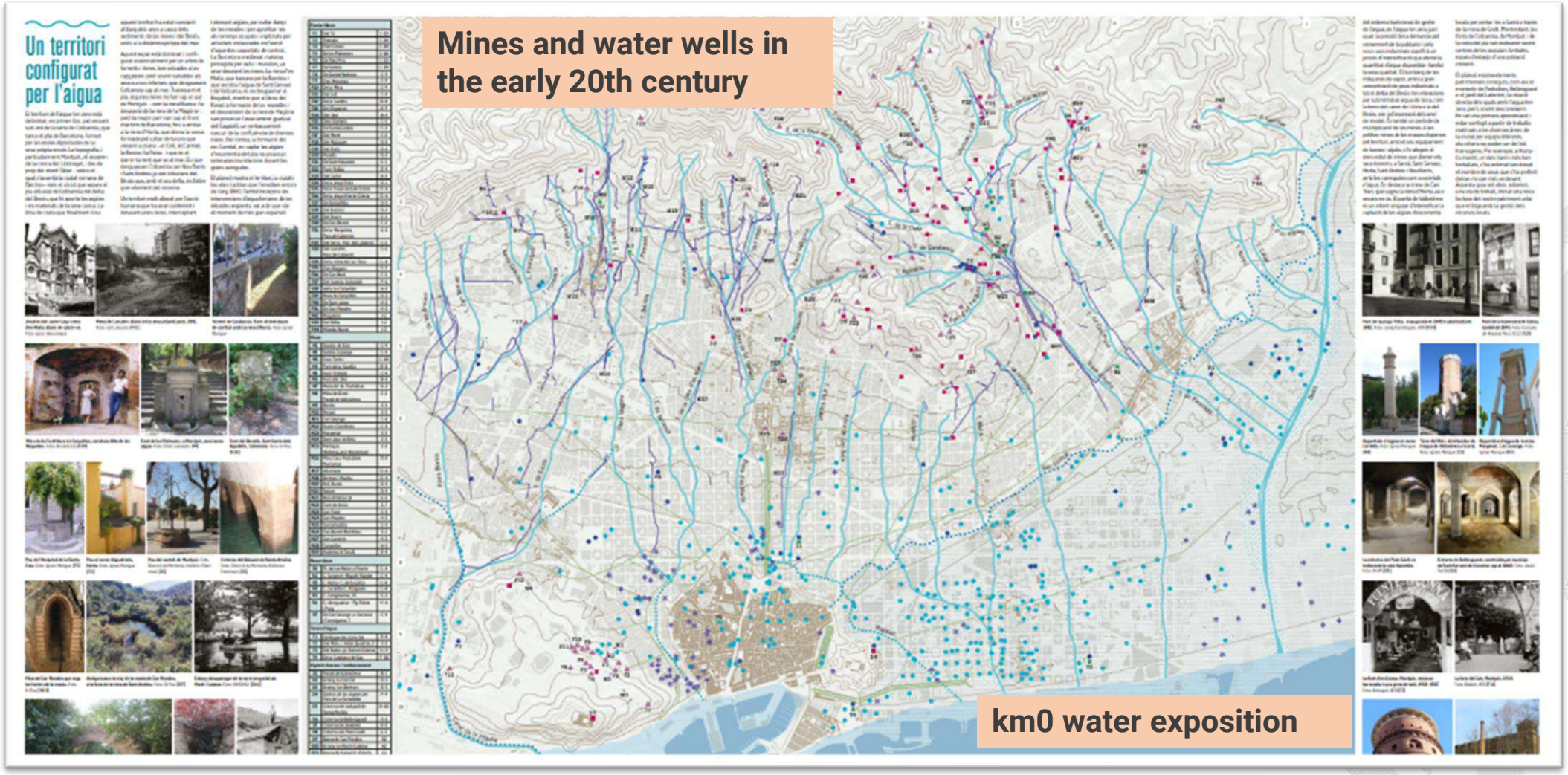


Park Güell – Antonio Gaudí. Incredible example of water-sensitive landscape design

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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

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SINCE 2005 SUDS HAVE BEEN BUILT IN BARCELONA

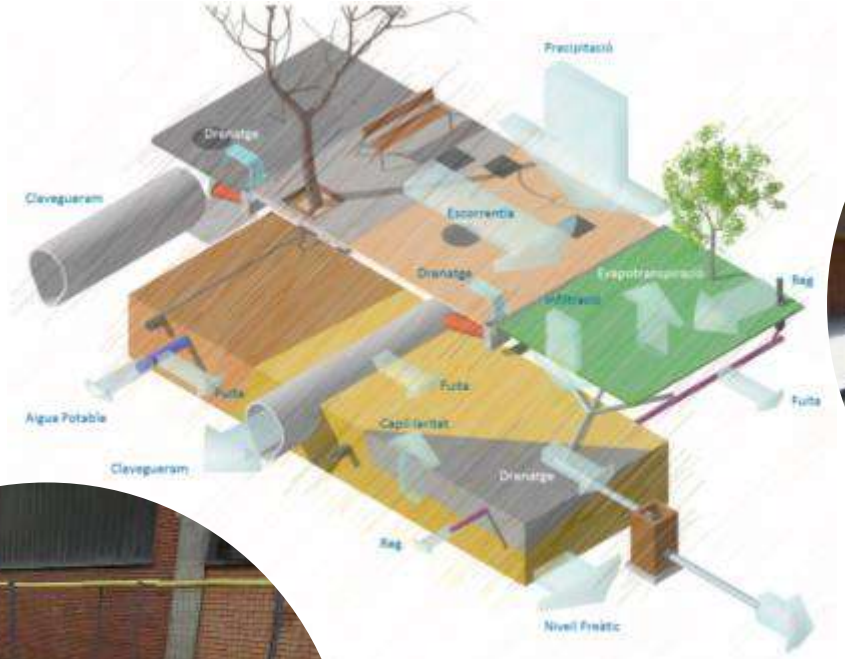


Different projects for urbanisation and remodelling of green spaces incorporate the philosophy of decentralised rain management with SUDS.



C/ Cristòfol de Moura

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SUDS may have various forms



- Depavimentation programmes
- Paviments permeabilisation
- Structured soils

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

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SUDS COMMISSION OF BARCELONA CITY COUNCIL

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

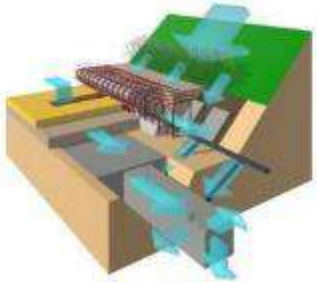
Entities initiating the commission:	Urban Projects
Barcelona Water Cycle	Sustainability Office
Parks and Gardens Institute	Mobility and Infrastructure
Municipal Urbanism Institute	Health Public Agency

The functions of the commission are:

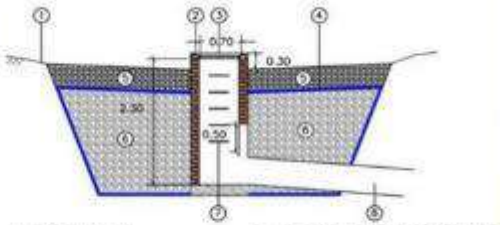
- Promote studies on the implementation, management and follow-up of SUDS.
- Systematize data management and projects related to SUDS techniques.
- Promote training in municipal technical services.
- To promote information to the citizenry, through signage, holding of conferences, on-line information.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

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1. **Design and implementation in scattered projects**.









2. **Individual research.**







3. **No design specification or maintenance.**









PILOT PHASE

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


FIGURA 17: DISPOSICIÓN DE DISPOSITIVOS DE INFILTRACIÓN

Fuente: elaboración propia.





2. Projects and experiences dissemination







ACCEPTANCE STAGE

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1. **Compilation of experiences of different municipal operators.**





2. **Establishment of the SUDS Commission.**







3. **Report on the SUDS of Barcelona.**







INTEGRATION PHASE

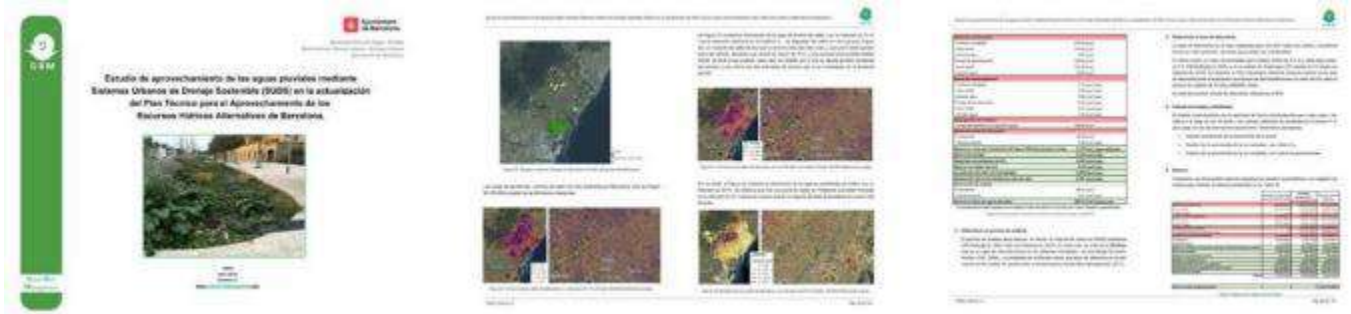
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1. **Promotion of SUDS in unique projects**





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



3. **Manual of Maintenance of SUDS.**



STAGE OF CHANGES

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THE BARCELONA CITY COUNCIL SUDS COMMISION MAKES PARADIGM SHIFT POSSIBLE

PILOT PHASE

- Finding solutions and minimizing problems
- Scattered innovative projects and actions
- Collection of cases and knowledge

ACCEPTANCE STAGE

- Dissemination of experiences and projects
- Collection of lessons learned
- Generalisation of concepts and strategies
- Aceptance of advantages and isadvantages

INTEGRATION PHASE

- Multidisciplinary structuring of knowledge
- Standard development
- Generalisation of knowledge, training
- Diversification of solutions

STAGE OF CHANGES

- Proposal for systematic implementation
- Establishment of procedures
- Adoption of working methods for conservation
- Allocation of operational resources

STANDARDISATION PHASE

- Generalisation of methods and systems
- Operation and maintenance
- Industrial and business integration
- Life cycle compliance and obsolescence







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PLARHAB 2020 – PDISBA 2020

LA 6. ACTION LINE SUDS

OBJECTVE:

Manage rains

P < 15 mm

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

V potential = 7,94 hm3/year

V managed = 5,71 hm^3/year



CONDITIONS OF PUBLIC SPACE

ROADS
SLOPE < 6%
WIDTH > 9 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	-	-

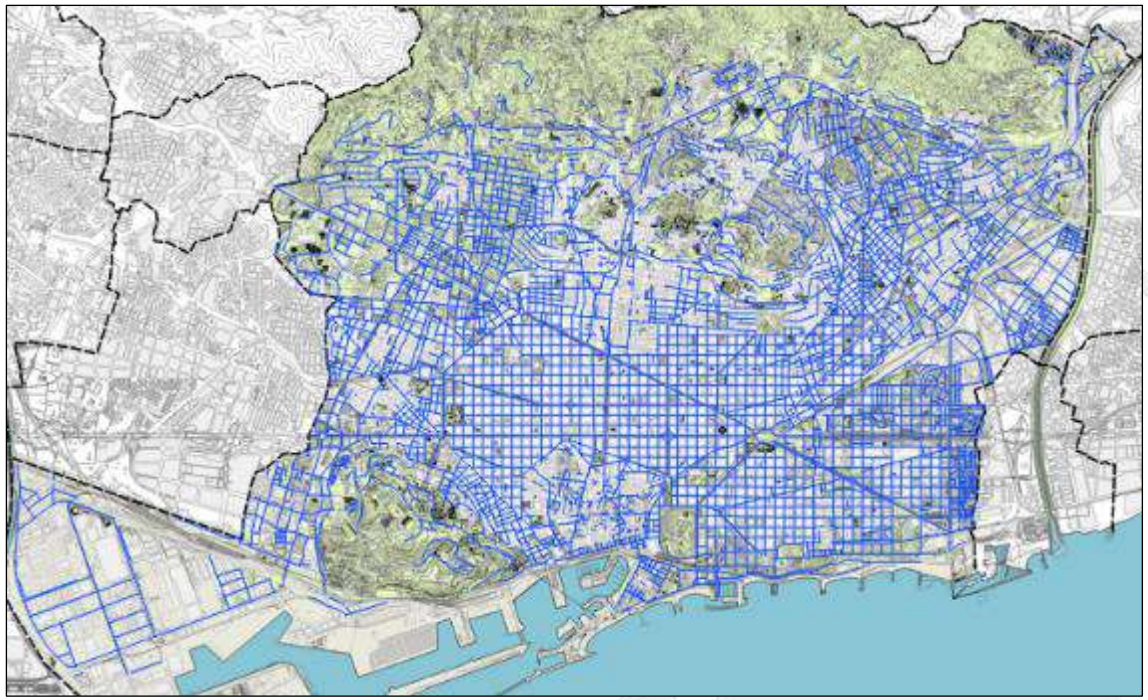
PDISBA - https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/119275; **PLARHAB**: https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/121158

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PLARHAB 2020 – PDISBA 2020

LA 6. ACTION LINE SUDS





MANAGED VOLUME AND POLLUTANTS RETAINED

Denomination	TECHNIQUES	Àrea SUDS total (m^2)	Volume Managed (m^3/any)	Pollutants retained (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

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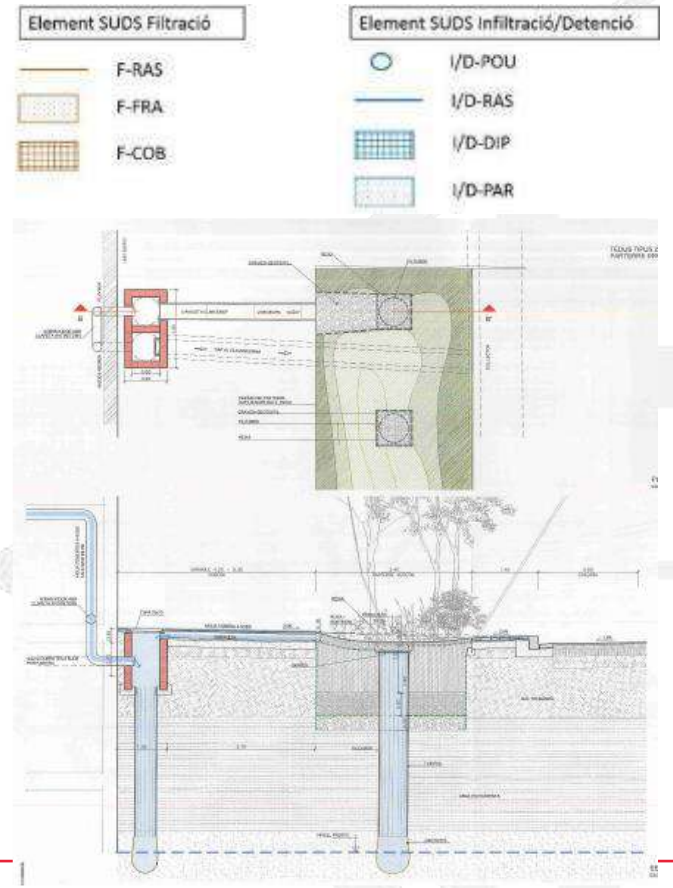
INVENTORY AND CARTOGRAPHY – GIS; MAINTENANCE PLATFORM - GMAO

1 – DATA MODEL DESIGN

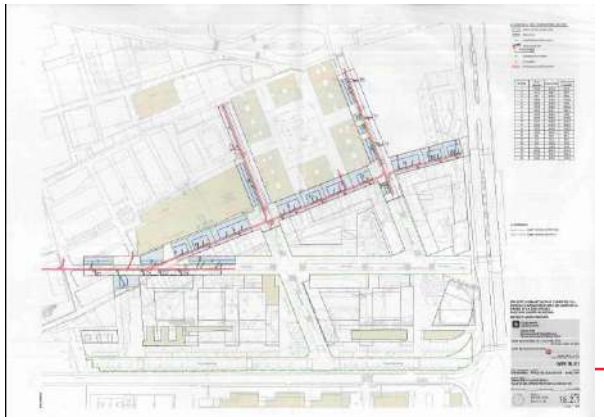
		Origen natural			Origen Artificial						Camps units		
3	Funció	Retenció	Filtració			Infiltració		Infiltració/Detenció				Tractament		
4	Tipologia de SUD	R-ALJ	F-RAS	F-FRA	F-COB	I-PAV	I-ESC	I/D-POU	I/D-RAS	I/D-DIP	I/D PAR	T-CUN	T-EST	T-BIO
17	Longitud		X	X					?		?	X		?
18	Ample		X	X					?		?	X		?
19	Àrea		X					X	?	X		X	X	
20	Batimetria		?	?	?	X	X	X	?	X	X	?	X	X
21	Superfície geotèxtil		X	X	?		X	X	?	X	X	X	X	X
22	Tipologia abocament (medi/clavegI/SU		X	X	?		?	?	?	?	?	X	?	?
23	Vegetació (SI/NO)		X	X	X		X	X	?	X	X	X	?	?
24	Tipus vegetació		X	X	X		X	X	?	X	X	X	X	X
25	Fondaria capa 1 -terra vegeta		X	X	X		X	X	?	X	X	X	?	X
26	Fondaria capa 2		X	X	X	X	X	X	?	X	X	X	?	X
27	Granulometria capa 2		X	X	X	X	X	X	?	X	X	X	?	X
28	Cota nivell freàtic		X	X		X	X	X	?	X	X	X	X	X
29	Permeabilitat terreny		X	X		X	X	X	?	X	X	X	X	X
30	Tipologia tub dren		X	?	X	X								
31	Diàmetre tub dren		X	?	X	X								
32	Longitud tub dren		X	?	X	X								
33	Pericons registre		X	?	X	X								
34	Dimensions pericons		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	Runores				X									

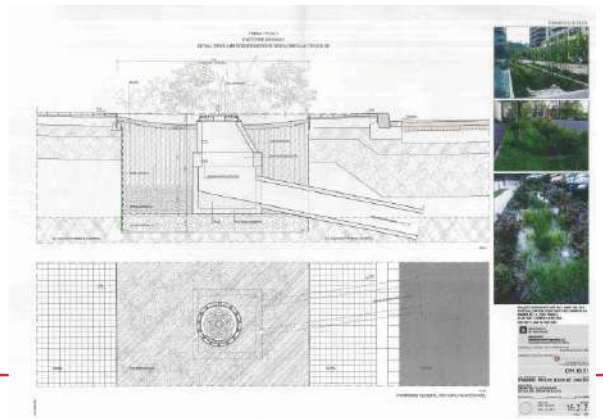
CAMPS COMUNS

DRENS



2 – STANDARISATION AS BUILT DOCUMENTATION







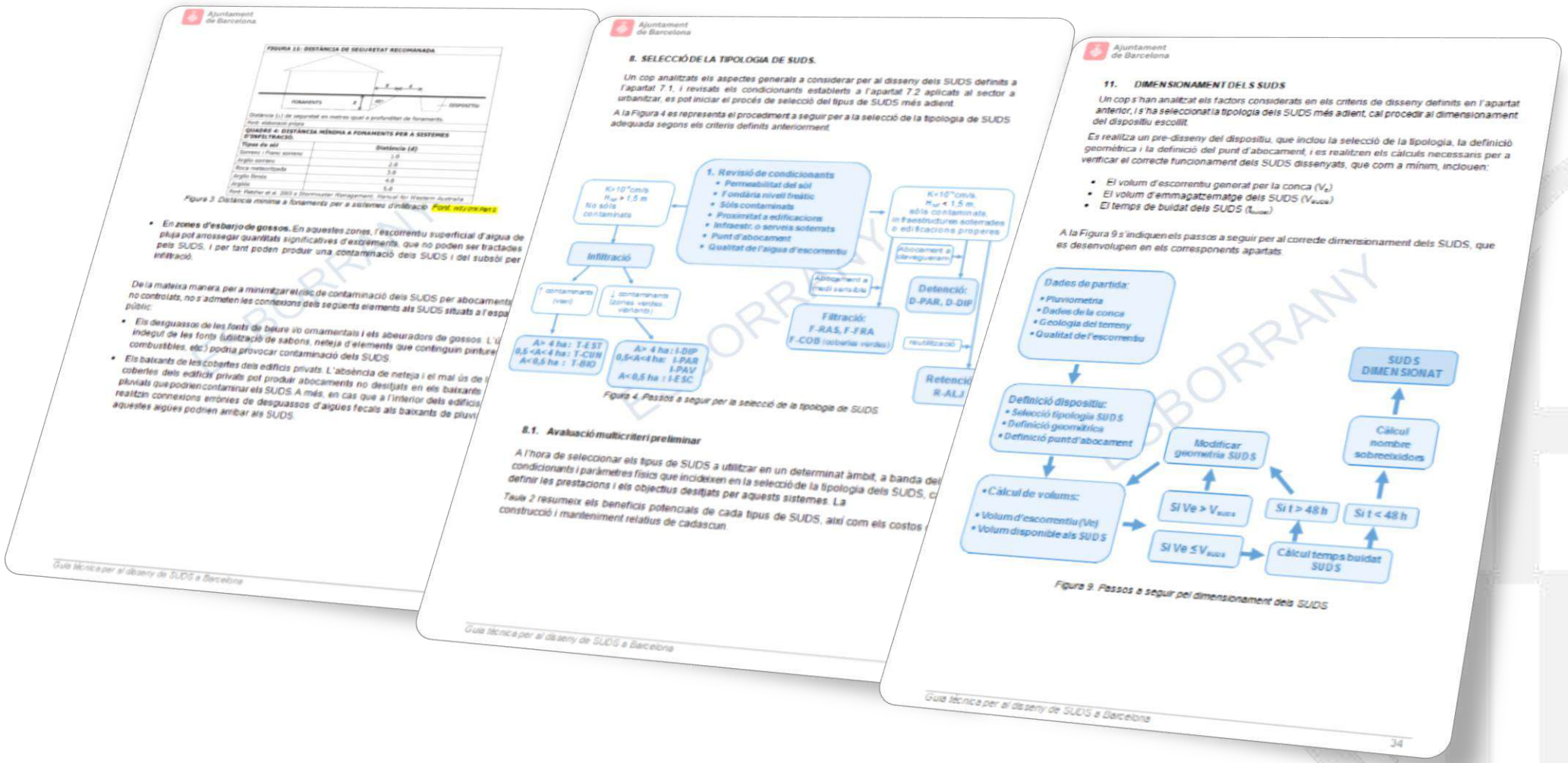




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TECHNICAL GUIDE FOR THE DESIGN OF SUDS (2020)

STANDARDISATION PHASE



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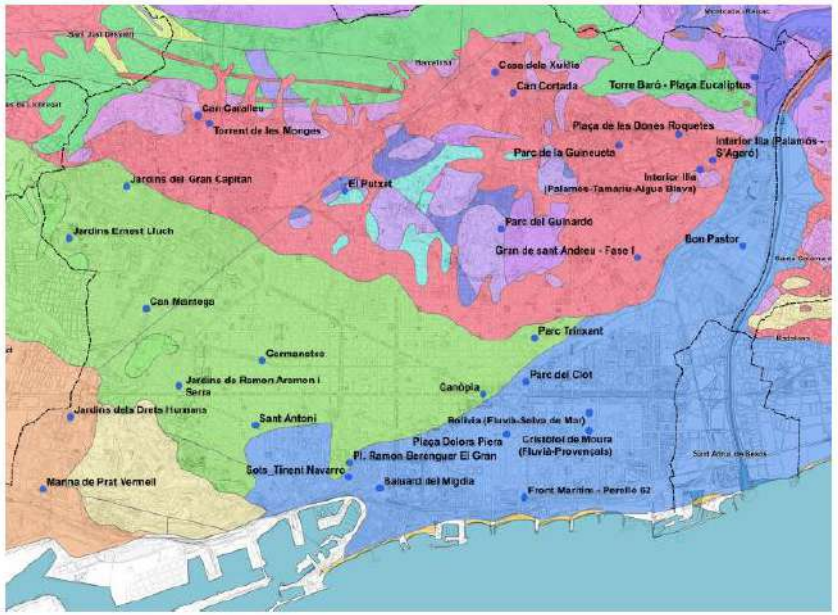
GENERAL CRITERIA FOR SUDS DESIGN

- 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

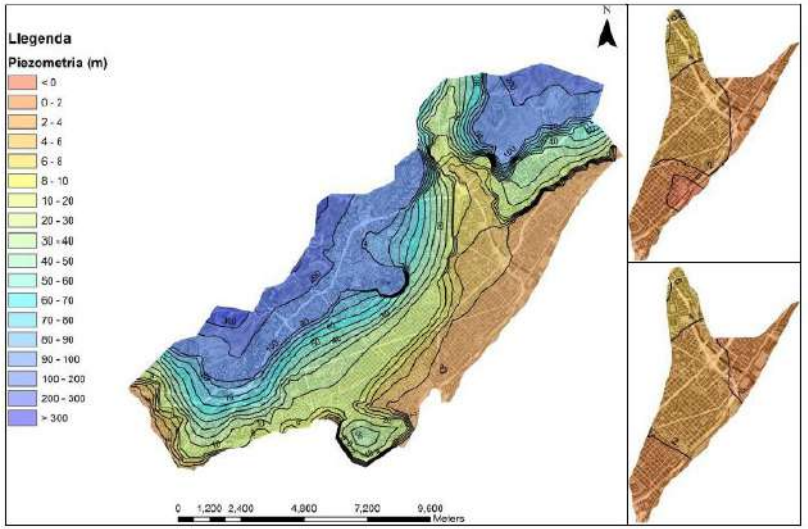


Figura 4.Mapes de piezometria als aqüífers superior (esquerra), mitjà (dalt dreta) i profund (baix dreta) a l'any 2017. (Font IDAEA-CSIC)

Hydrogeology



Permeability test

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCHERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
5.- USOS AMBIENTALES					
CALIDAD 5.1 a) Recarga de acuíferos por percolacion localizada a través del terreno.	No se fija límite	1.000 UFC/100 mL	35 mg/L	No se fija límite	N_T[1] 10 mg N/L NO_3: 25 mg NO_3/L Art. 257 a 259 del RD 849/1986
CALIDAD 5.2 a) Recarga de acuíferos por inyección directa	1 huevo/10 L	0 UFC/100 mL	10 mg/L	2 UNT	

Infiltration Water Quality (RD 1620/2007)







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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



Tipus de SUDS emprats:



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

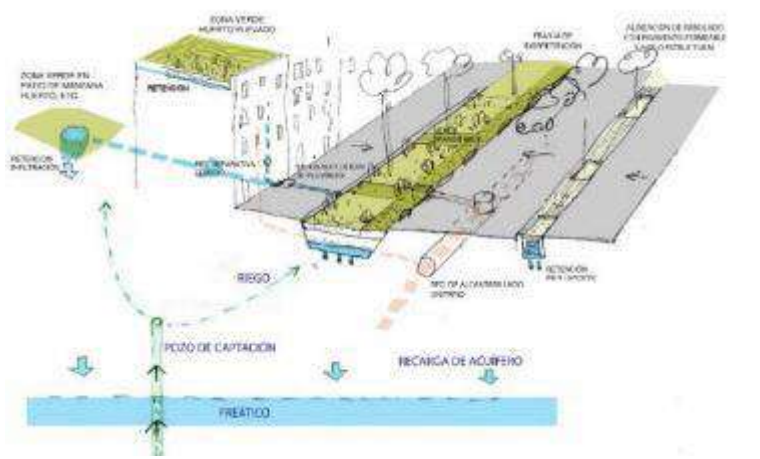
Descripció:

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 sobreeiximent 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.

Referències addicionals als projectes:

Soto-Fernández (2013 i 2016).

Plànols i esquemes:



Estat actual:

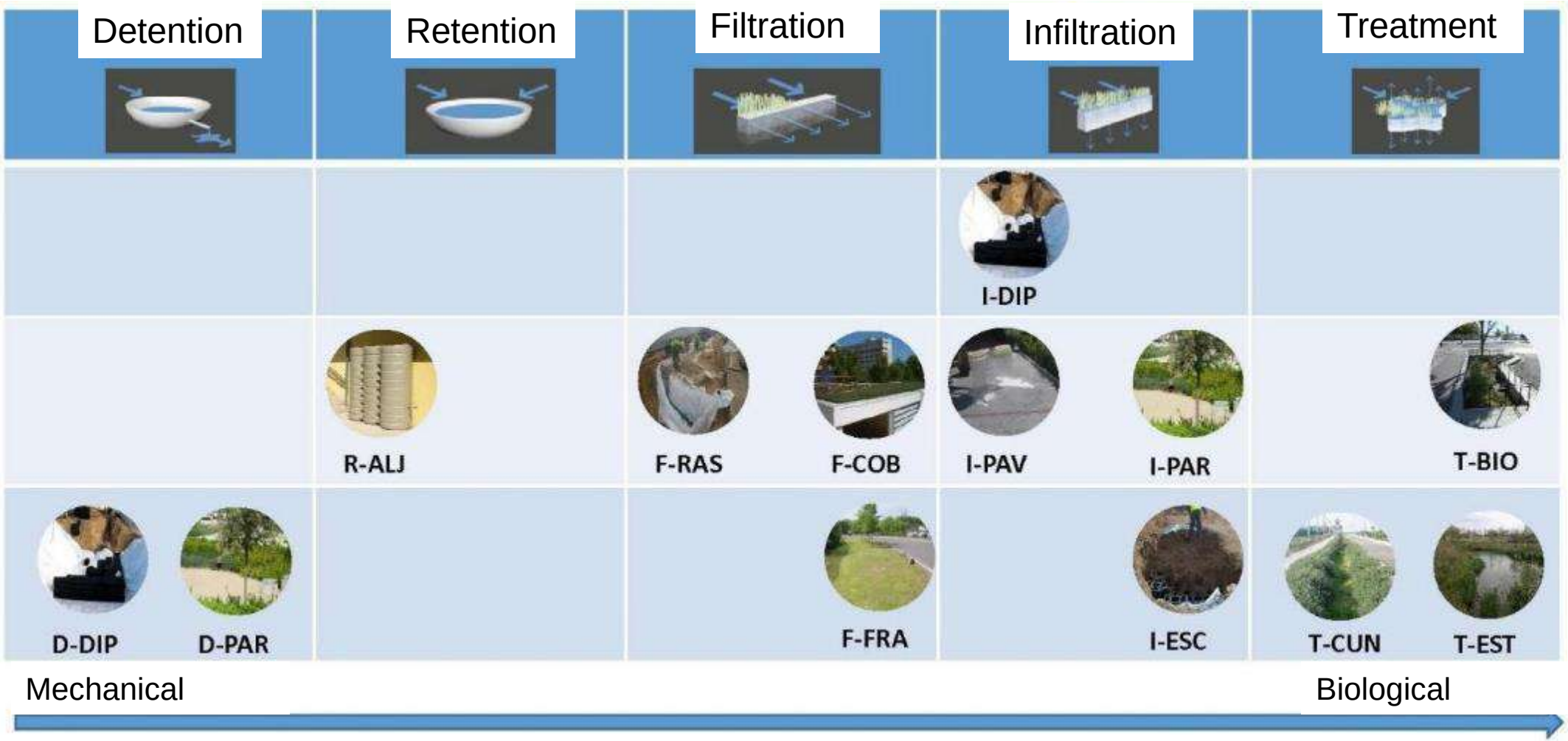






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FUNCTIONS VS. TECHNIQUES



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MULTI-CRITERIA EVALUTION

SUDS TECHNIQUES		Peak flow reduction	Runoff volume reduction		Water quality improvement	Health anD citizen welfare benefits	Biodiversity, Urban Ecosystem benefits	Construction cost	Maintenance cost
			Frequent events	Extreme 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

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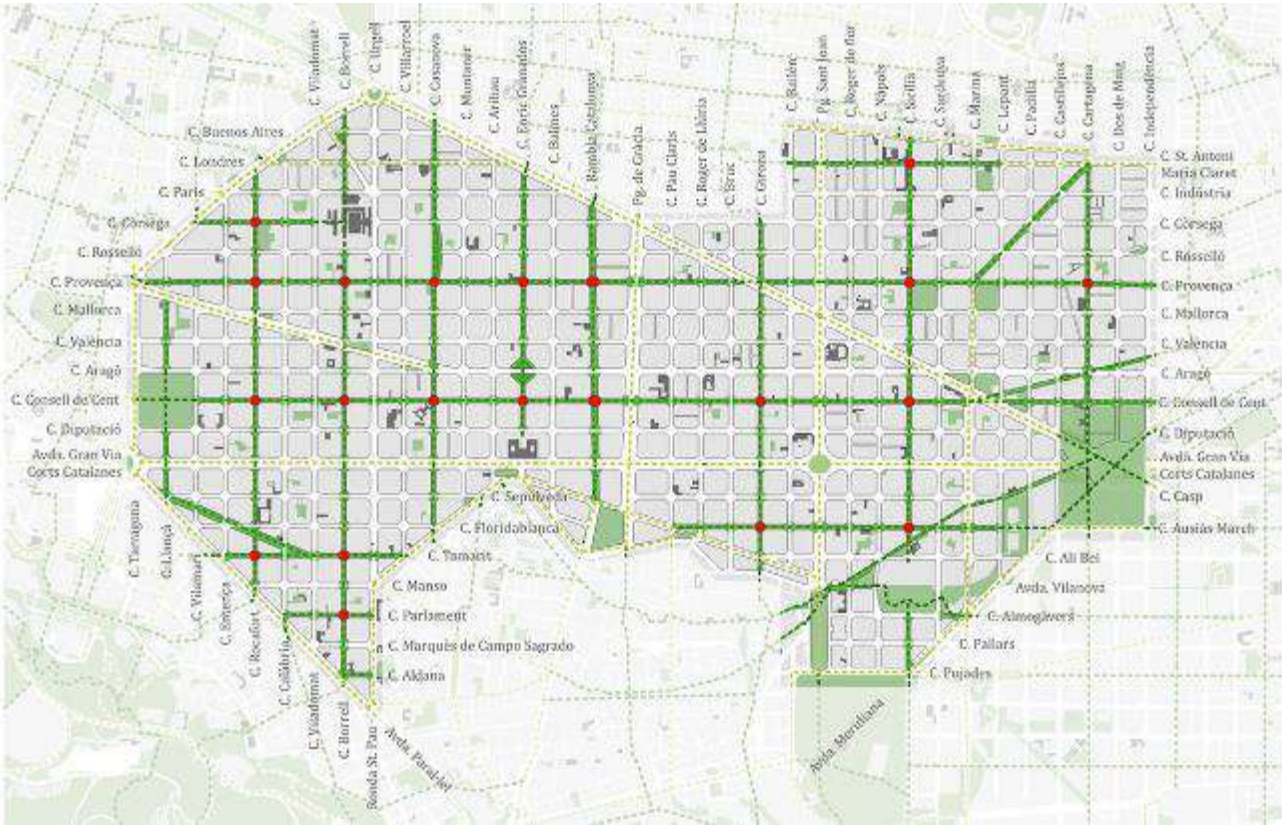


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BARCELONA SUPERBLOCKS: NEW STAGE AT EIXAMPLE DISTRICT

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



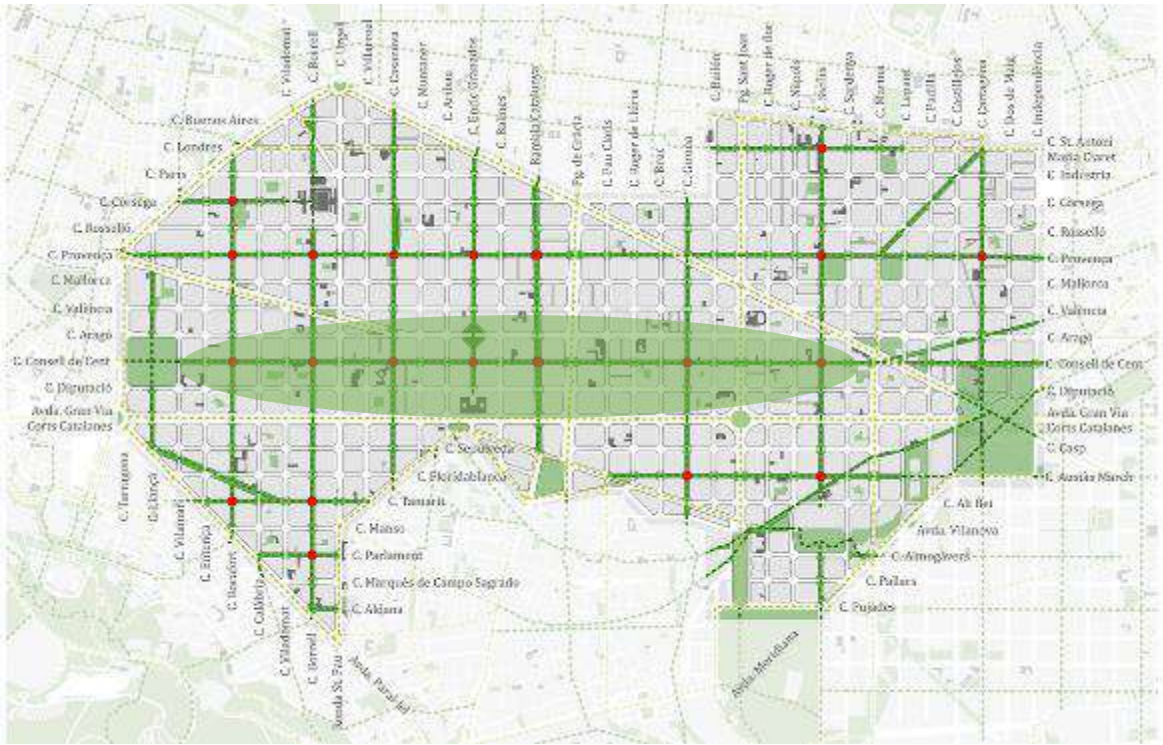


This new stage will make it possible to extend the super-blocks transformation to the entire **Eixample district**, a priority area of action with the potential for a huge impact on the rest of the city due to its population density, volume of traffic, high pollution level and the need for more pleasant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

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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:

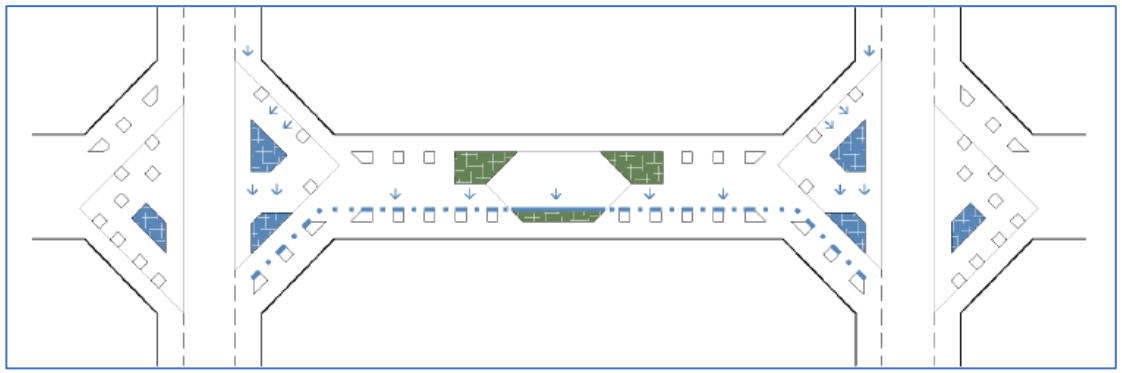
1. Consell de Cent – Rocafort
2. Consell de Cent – Borrell
3. Consell de Cent - Enric Granados
4. Consell de Cent – Girona

TOTAL: 0,8 Ha (aprox)

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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.

SUDS MAINTENANCE CONTRACT

New maintenance service coordinated by BCASA (1.285.558,53 €/Year)

- **Green Lot**

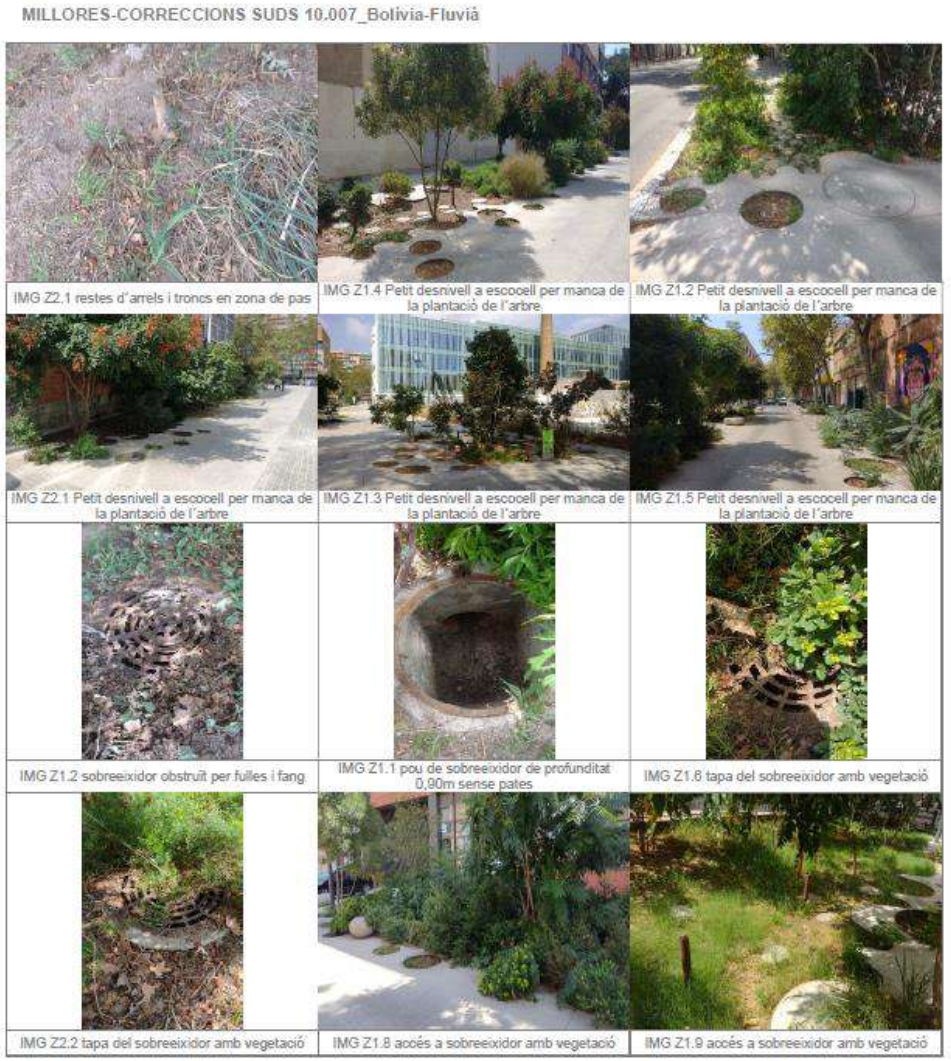
Municipal Institute of Parks and Gardens

- **Blue Lot**

BCASA

- **Grey Lot**

Mobility and Infrastructures



We are working on studies to evaluate the beneficial effect of SUDS on the biodiversity and quality of soils and groundwater.

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21st-century streets



New environment infrastructure	Proximity Play and well-being areas	New materiality	Continuities Water sensitive design	Accessibility

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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

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/PlecPrescripcionsTecniquesDrenatge_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!

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