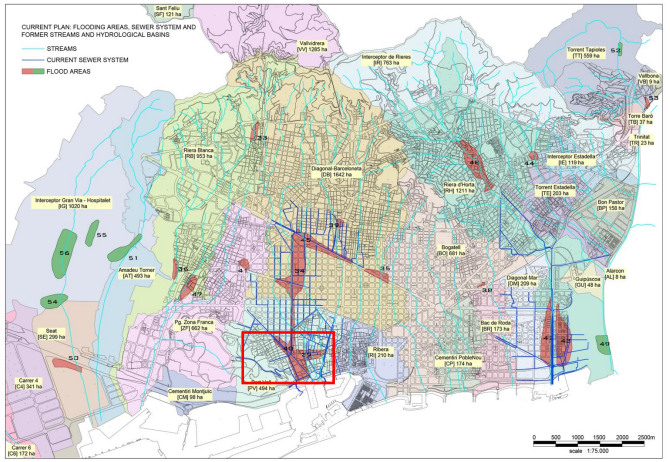
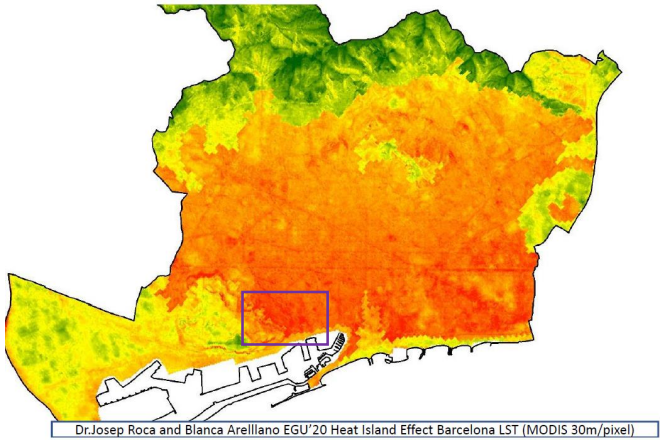
REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs

(Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

The aim of this communication is showing the research conducted during the last years on the effects in Barcelona city of WSUDs (Water Urban Design Systems) on reduction of water consumption, moderation of land surface temperatures and regulation of rainwater runoff, especially in pluvial flood-prone urban areas.
In this case we focus in el Raval zone, a flood-prone urban area inside the Barcelona heat island effect.





Dr.Josep Roca and Blanca Arelllano EGU'20 Heat Island Effect Barcelona LST (MODIS 30m/pixel)

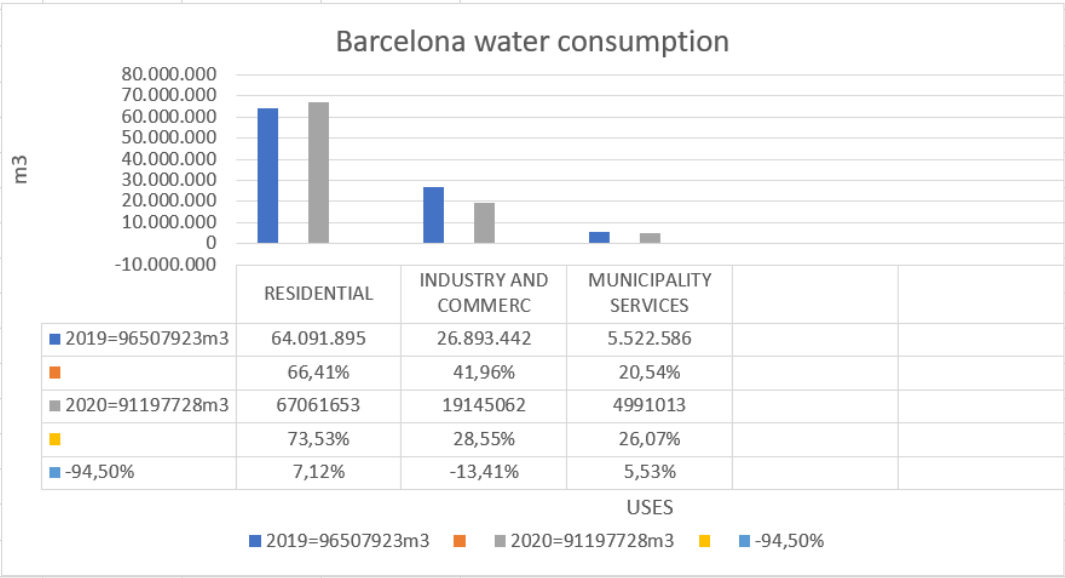
REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

1. REDUCTION IN WATER CONSUMPTION:

TOTAL WATER CONSUMPTION IN BARCELONA=91197728 m3

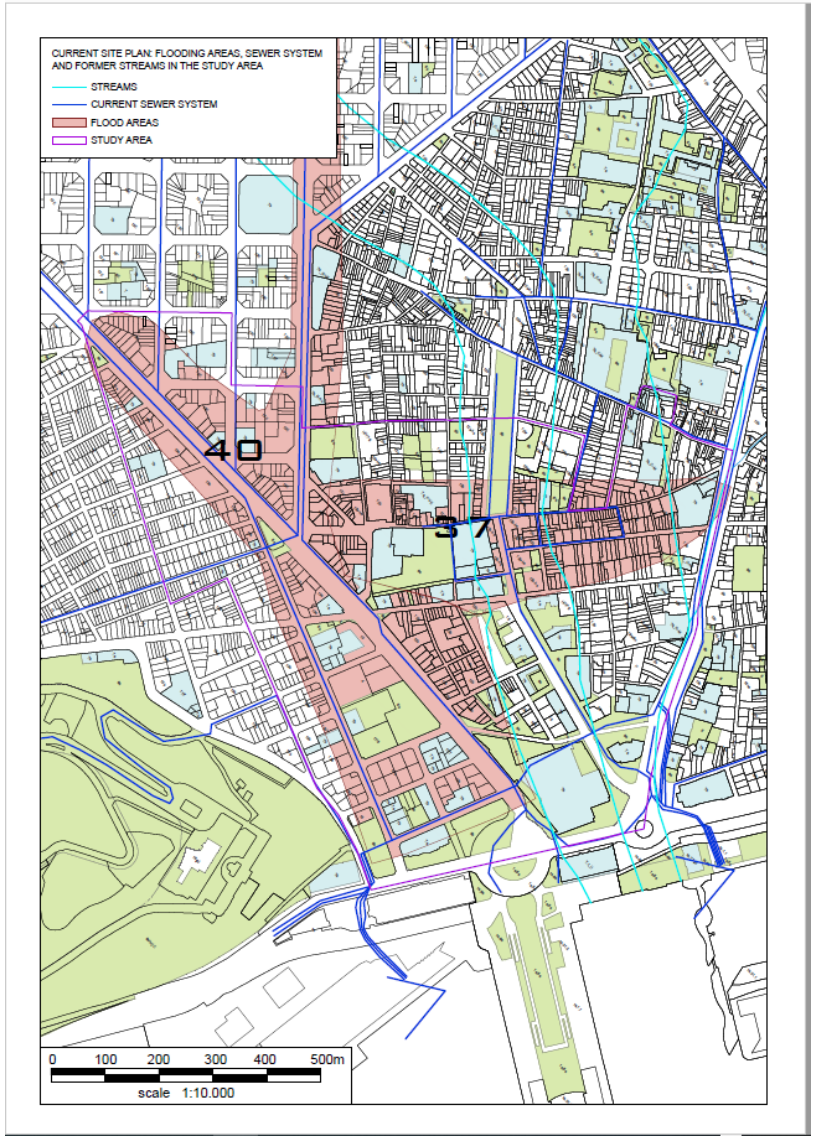
in 2020 residential water consumption=73,53% (phreatic water supply was a 1,165% of the total water supply of Barcelona in 2018; the use was for Municipality services).



	RESIDENTIAL	INDUSTRY AND COMMERC	MUNICIPALITY SERVICES
2019=96507923m3	64.091.895	26.893.442	5.522.586
	66,41%	41,96%	20,54%
2020=91197728m3	67061653	19145062	4991013
	73,53%	28,55%	26,07%
-94,50%	7,12%	-13,41%	5,53%

https://www.bcn.cat/estadistica/catala/dades/economia/consum/evoconsum/coev04.htm#inicio

This communication is focused in reduction of the residential water consumption



Own source redrawn with the Barcelona Municipality and BCASA information

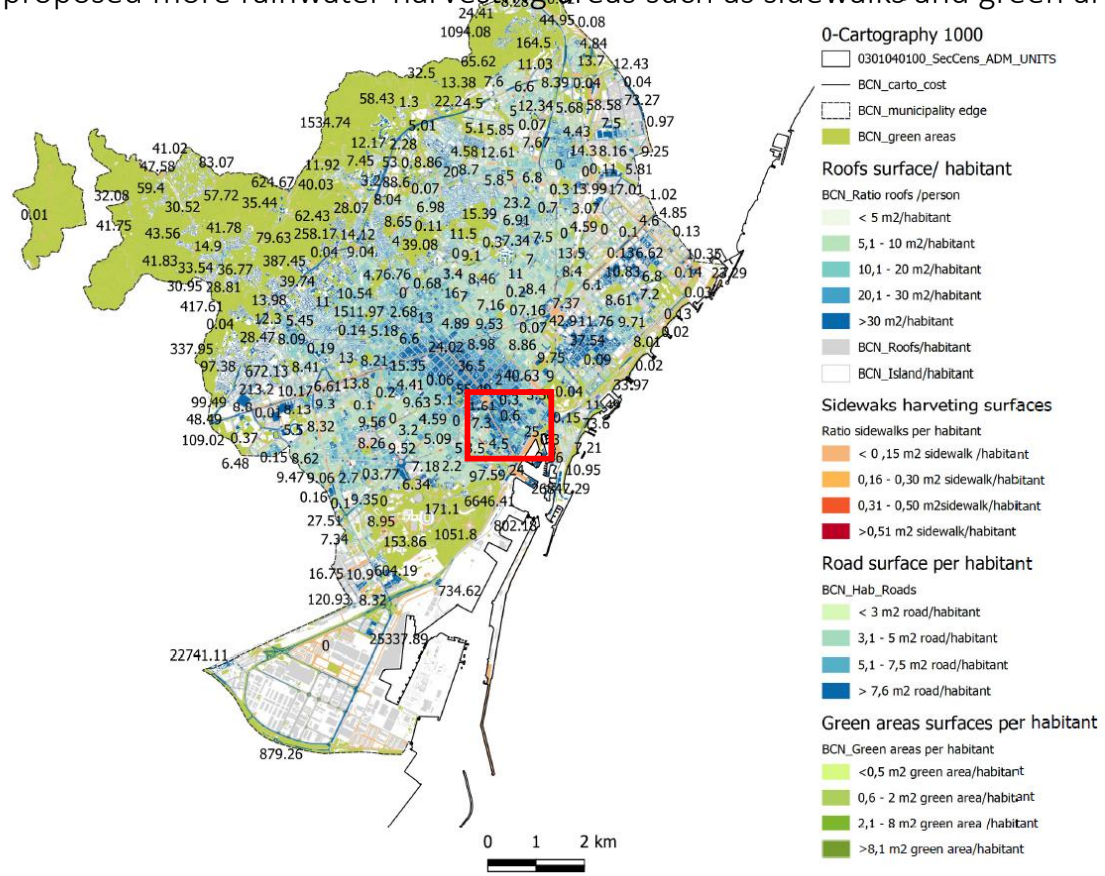
RAVAL AREA

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

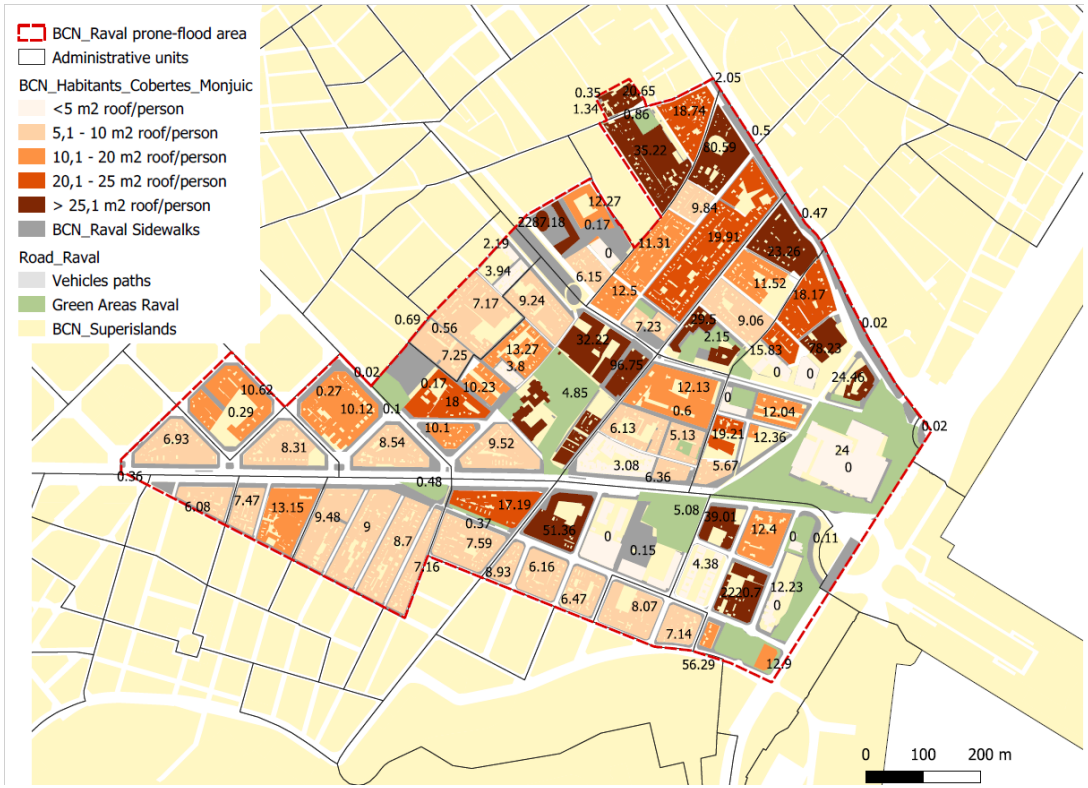
M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

1. REDUCTION IN WATER CONSUMPTION:

A first análisis about green areas surfaces-roofs surfaces and sidewalks ratios per habitant of administrative units is done to have an idea of wich surfaces have the bigger ratio in el Raval área to decide a rainwater harvesting strategy . El Raval is a very dense area, with an intense land occupation for which it's necessary to use blue roofs to harvest wáter. The calculations to harvest at least a 21% (or 1/5 more or les) of the residential wáter consumption of the area have been made inversly. The result is that we need 16,95m2 per habitant to reduce a 21% wáter consumption. As roofs have a lower ratio it's necessary to proposed more rainwater harvesting areas such as sidewalks and green áreas of the public space.



Own source calculated with Barcelona Municipality cartography and Catastro information with GIS



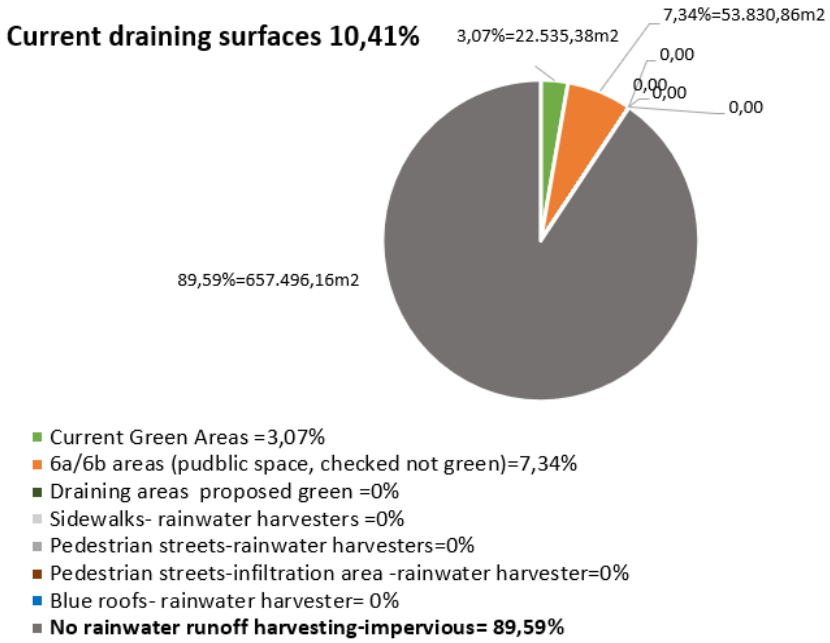
Own source calculated with Barcelona Municipality cartography and Catastro information with GIS

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

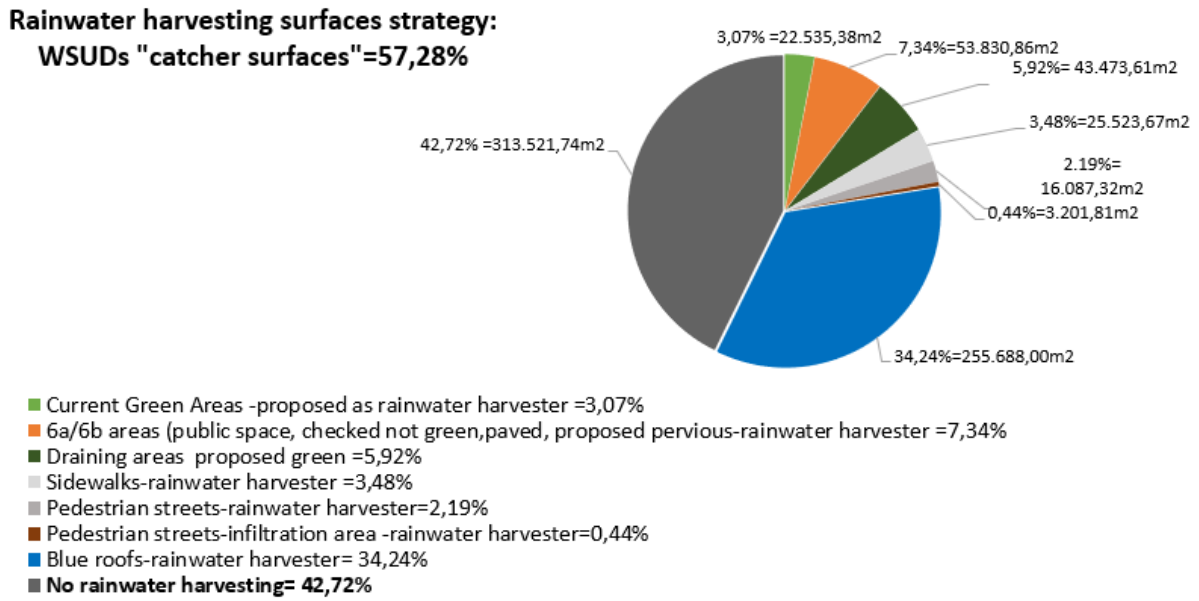
1. REDUCTION IN WATER CONSUMPTION:

"RAVAL" CURRENT INFILTRATING SURFACES



Own source calculated with Barcelona Municipality cartography information

PROPOSED RAINWATER RUNOFF HARVESTING SURFACES:



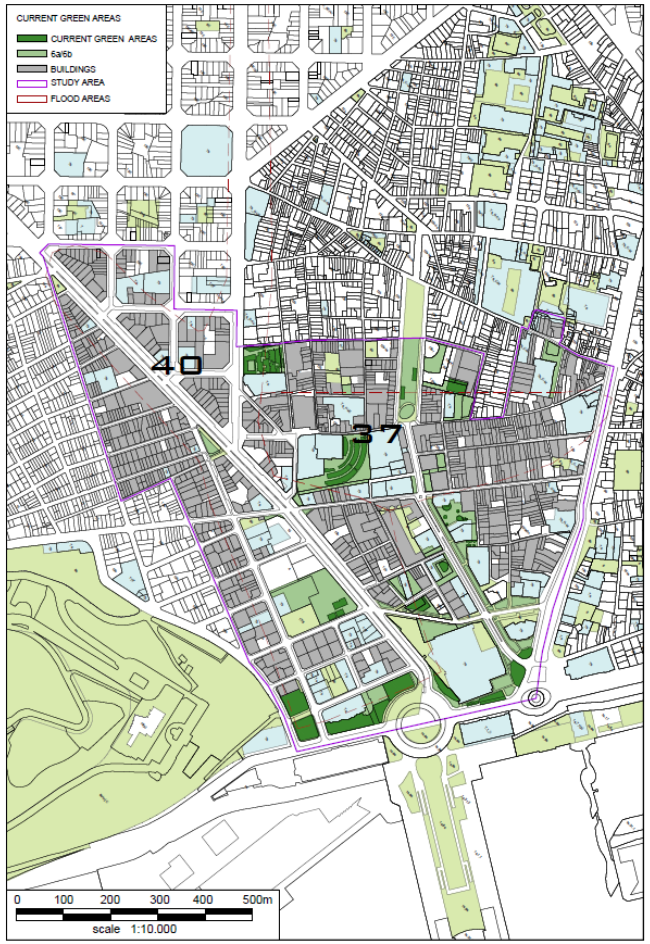
Own source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

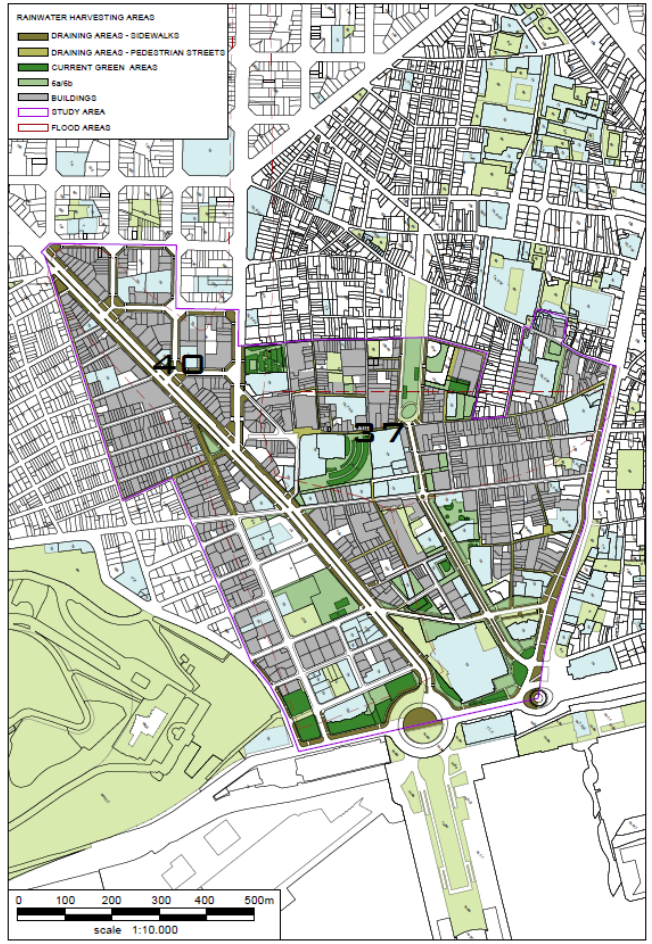
1. REDUCTION IN WATER CONSUMPTION:

"RAVAL" CURRENT INFILTRATING SURFACES



Own source redrawn with Barcelona Municipality cartography information

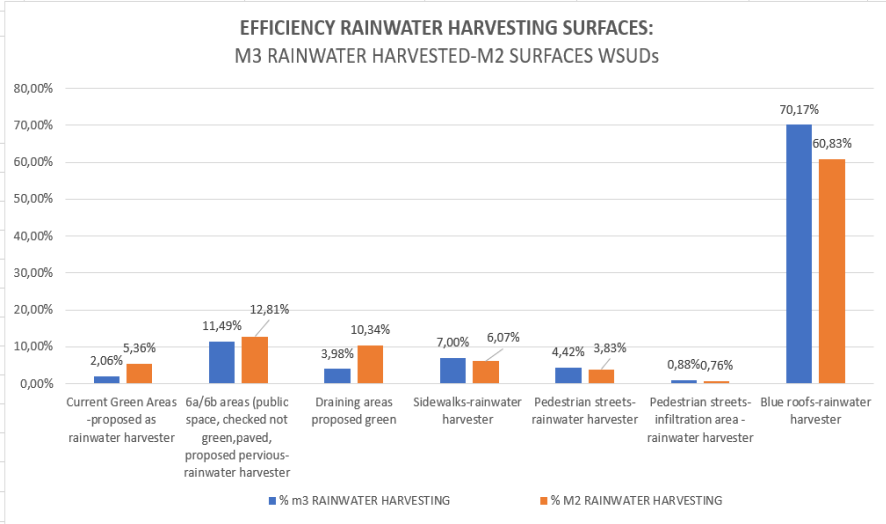
PROPOSED RAINWATER RUNOFF HARVESTING SURFACES:



Own source

WSUDs EFFICIENCY RAINWATER HARVESTING SURFACES m3-WSUDs m2 SURFACES

As water harvesting depends on the C (runoff coefficient of the infitrating surfaces we need to analyze which construction systems are more efficient to harvest water).



REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

1. **REDUCTION IN WATER CONSUMPTION**: calculations. In this case, the runoff coefficient ("C") of each surface has been used to have an average of 0,78. The runoff coefficients have been taken from the "Guía Básica de Diseño de Sistemas de Gestión Sostenible de Aguas Pluviales en Zonas Verdes y otros Espacios Libres" by the Madrid Municipality.

The results are that we can harvest about a 21% of the water consumption for all the habitants of the studied area dwellings

21 % OF DRINKABLE WATER CONSUMPTION REDUCTION FOR ALL THE DWELLINGS IN THE STUDY CASE AREA. REQUIRED RATIO/NUMER OF PERSONS=16,95

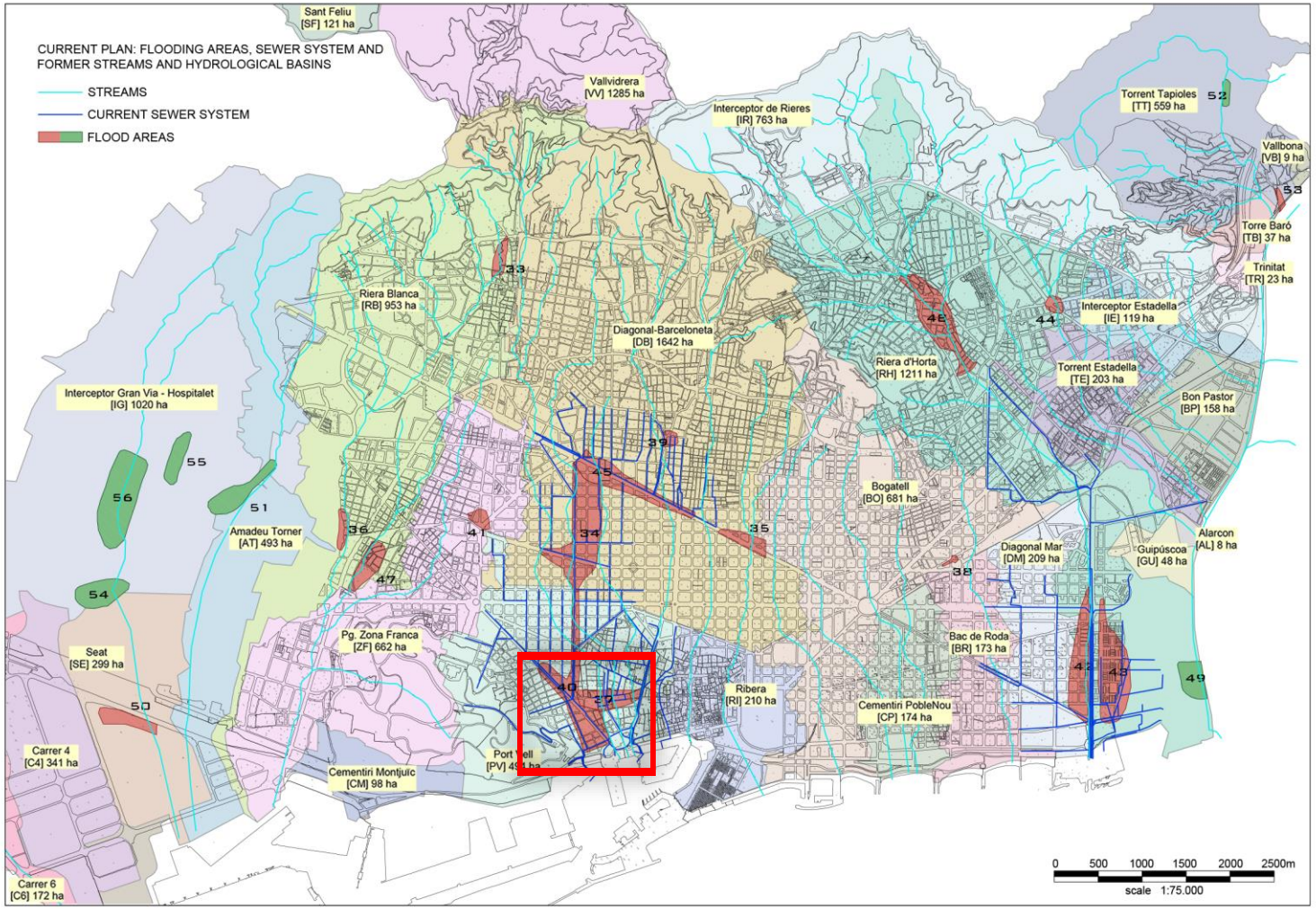
DAYS	MONTH	RAIN AVERAGE (mm)	WATER HARVESTING (m3)	ACC. VOLUME (m3)	REQUIREMENTS(M3)	ACC.REQUIREMENTS (M3)	DIFFERENCE (M3)	%COVERED REQUIREMENTS
30	September	61,92	20.305,74	20.305,74	18.008,55	18.008,55	2.297,19	1,13
31	October	73,65	24.152,42	44.458,16	18.608,84	36.617,39	7.840,77	1,21
30	November	75,33	24.703,35	69.161,50	18.008,55	54.625,94	14.535,57	1,27
31	December	26,91	8.824,73	77.986,24	18.608,84	73.234,77	4.751,47	1,06
31	January	33,88	11.110,44	89.096,68	18.608,84	91.843,61	-2.746,93	0,97
28	February	31,81	10.431,61	99.528,29	16.807,98	108.651,59	-9.123,29	0,92
31	March	71,38	23.408,00	122.936,30	18.608,84	127.260,42	-4.324,12	0,97
30	April	65,15	21.364,97	144.301,27	18.008,55	145.268,97	-967,70	0,99
31	May	54,54	17.885,58	162.186,84	18.608,84	163.877,81	-1.690,96	0,99
30	June	34,56	11.333,44	173.520,28	18.008,55	181.886,36	-8.366,08	0,95
31	July	40,05	13.133,80	186.654,08	18.608,84	200.495,19	-13.841,11	0,93
31	August	19,42	6.368,50	193.022,58	18.608,84	219.104,03	-26.081,45	0,88
365		588,60	193.022,58	1.383.157,95	219.104,03	1.420.874,60	-37.716,64	0,97

Own source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

2. RAINWATER RUNOFF INFILTRATION:

BARCELONA CURRENT FLOOD-PRONE AREAS,CURRENT SEWER SYSTEMS, FORMER STREAMS AND HYDROLOGICAL BASINS

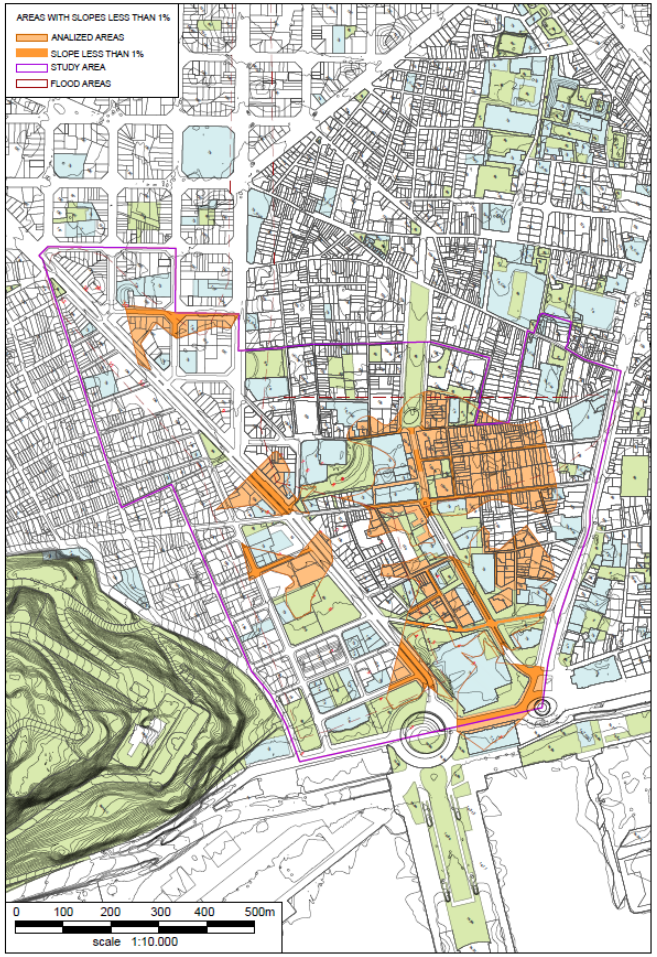


Own source redrawn with the Barcelona Municipality and BCASA information

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

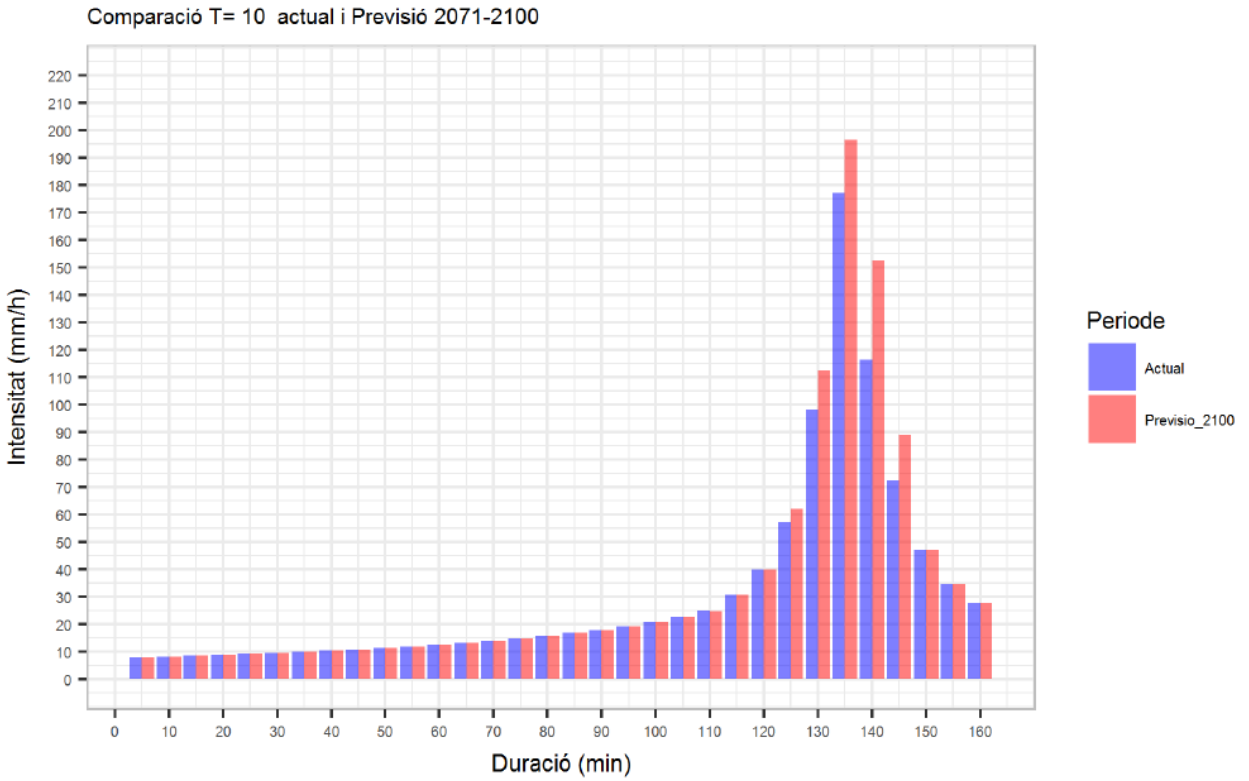
2. RAINWATER RUNOFF INFILTRATION:

CAUSES OF THE FLOODS IN THE AREA: SLOPES WITH LESS THAN A 1%



Own source redrawn with the Barcelona Municipality cartography, QGIS and CAD.

AND INCREASE OF THE INTENSITY AND DECREASE OF THE RAIN FREQUENCIES: comparative hyetograms 2071-2100 for T=10



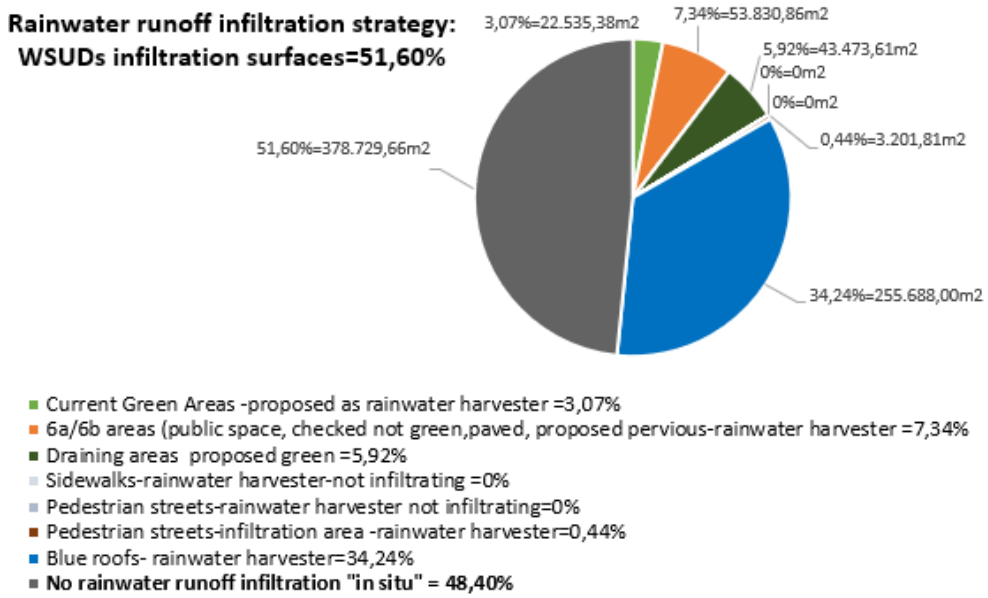
Hyetogram by https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/119275

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

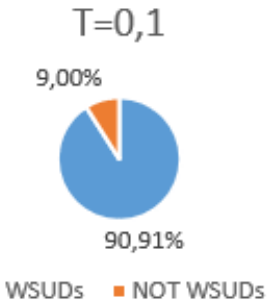
2. RAINWATER RUNOFF INFILTRATION:

PROPOSED INFILTRATION SURFACES



Own source

IF T=0,1 WSUDs MANAGE A 90,91% OF THE RUNOFF of the public space if C=0,9 in the worst of the cases. The blue roof is not included because it harvests all of the runoff instead of saturating the current sewerage (thus, also reducing the floods).



Q=(c x It x A) / K **"Instrucción 5.2. IC Drenaje Superficial".**

T= 1 y 0,1 WSUDs

T=0,1 YEAR	**K=lime-sand-gravel subsoil=0,00001**		**C=0,9**	**(worst of the cases)**							DEPO (M3)	2.000,00
Duration (min)	**Intensity (mm/h)**	**C**	**K**	**Area Sector(m2)**	**A Wsuds (m2)**	**Q rain (m3/seg)**	**Rain Volume (m3)**	**Q infiltrated (m3/seg)**	**Vfiltrated (m3)**	**Vnot filtrated (m3)**	**V accumulated (m3)**	**V overflow to the rainwater harvesting system (m3)**
5	4	0,9	0,00001	478.174,39	123.041,66	0,48	143,45	1,23	369,12	0,00	0,00	0,00
10	10	0,9	0,00001	478.174,39	123.041,66	1,20	358,63	1,23	369,12	0,00	0,00	0,00
15	30	0,9	0,00001	478.174,39	123.041,66	3,59	1.075,89	1,23	369,12	706,77	706,77	0,00
20	40	0,9	0,00001	478.174,39	123.041,66	4,78	1.434,52	1,23	369,12	1.065,40	1.772,17	0,00
25	30	0,9	0,00001	478.174,39	123.041,66	3,59	1.075,89	1,23	369,12	706,77	2.000,00	0,00
30	15	0,9	0,00001	478.174,39	123.041,66	1,79	537,95	1,23	369,12	168,82	2.000,00	647,75
35	7	0,9	0,00001	478.174,39	123.041,66	0,84	251,04	1,23	369,12	0,00	2.000,00	0,00
40	6	0,9	0,00001	478.174,39	123.041,66	0,72	215,18	1,23	369,12	0,00	2.000,00	0,00
45	5	0,9	0,00001	478.174,39	123.041,66	0,60	179,32	1,23	369,12	0,00	2.000,00	0,00
50	4	0,9	0,00001	478.174,39	123.041,66	0,48	143,45	1,23	369,12	0,00	2.000,00	0,00
55	3	0,9	0,00001	478.174,39	123.041,66	0,36	107,59	1,23	369,12	0,00	2.000,00	0,00
60	2	0,9	0,00001	478.174,39	123.041,66	0,24	71,73	1,23	369,12	0,00	2.000,00	0,00
65	1,5	0,9	0,00001	478.174,39	123.041,66	0,18	53,79	1,23	369,12	0,00	2.000,00	0,00
70	1	0,9	0,00001	478.174,39	123.041,66	0,12	35,86	1,23	369,12	0,00	2.000,00	0,00
							5.684,30		5.167,75	2.647,75	2.000,00	647,75

Own source

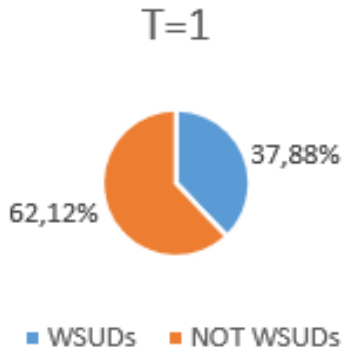
REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

2. RAINWATER RUNOFF INFILTRATION:

CALCULATION FOR T=1

T=1 YEAR	K=lime-sand-gravel subsoil=0,00001	C=0,9	(worst of the cases)		C=0,7	Ksuds=1 permeabiliz	DEPO (M3)	2.000,00

Duration (min)	Intensity (mm/h)	C	K	Area Sector(m2)	A Wsuds (m2)	Q rain (m3/seg)	Rain Volume (m3)	Q infiltrated (m3/seg)	Vfiltrated (m3)	Vnot filtrated (m3)	V accumulated (m3)	V overflow to the rainwater harvesting system (m3)
5	19,2	0,9	0,00001	478.174,39	123.041,66	2,30	688,57	1,23	369,12	319,45	319,45	0,00
10	27,01	0,9	0,00001	478.174,39	123.041,66	3,23	968,66	1,23	369,12	599,54	918,98	0,00
15	92,6	0,9	0,00001	478.174,39	123.041,66	11,07	3.320,92	1,23	369,12	2.951,80	2.000,00	1.870,78
20	92,6	0,9	0,00001	478.174,39	123.041,66	11,07	3.320,92	1,23	369,12	2.951,80	2.000,00	2.951,80
25	37,65	0,9	0,00001	478.174,39	123.041,66	4,50	1.350,24	1,23	369,12	981,12	2.000,00	981,12
30	21,95	0,9	0,00001	478.174,39	123.041,66	2,62	787,19	1,23	369,12	418,07	2.000,00	418,07
35	17,36	0,9	0,00001	478.174,39	123.041,66	2,08	622,58	1,23	369,12	253,46	2.000,00	253,46
40	14,43	0,9	0,00001	478.174,39	123.041,66	1,73	517,50	1,23	369,12	148,38	2.000,00	148,38
45	13,02	0,9	0,00001	478.174,39	123.041,66	1,56	466,94	1,23	369,12	97,81	2.000,00	97,81
50	11,61	0,9	0,00001	478.174,39	123.041,66	1,39	416,37	1,23	369,12	47,25	2.000,00	47,25
55	10,22	0,9	0,00001	478.174,39	123.041,66	1,22	366,52	1,23	369,12	0,00	2.000,00	0,00
60	8,87	0,9	0,00001	478.174,39	123.041,66	1,06	318,11	1,23	369,12	0,00	2.000,00	0,00
65	7,57	0,9	0,00001	478.174,39	123.041,66	0,90	271,48	1,23	369,12	0,00	2.000,00	0,00
70	6,36	0,9	0,00001	478.174,39	123.041,66	0,76	228,09	1,23	369,12	0,00	2.000,00	0,00
							13.644,11		5.167,75	8.768,66	2.000,00	6.768,66



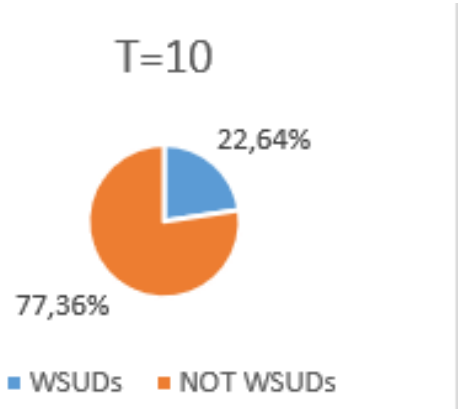
Own source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

2. RAINWATER RUNOFF INFILTRATION:

CALCULATION FOR T=10 (the legal "T" for Barcelona)

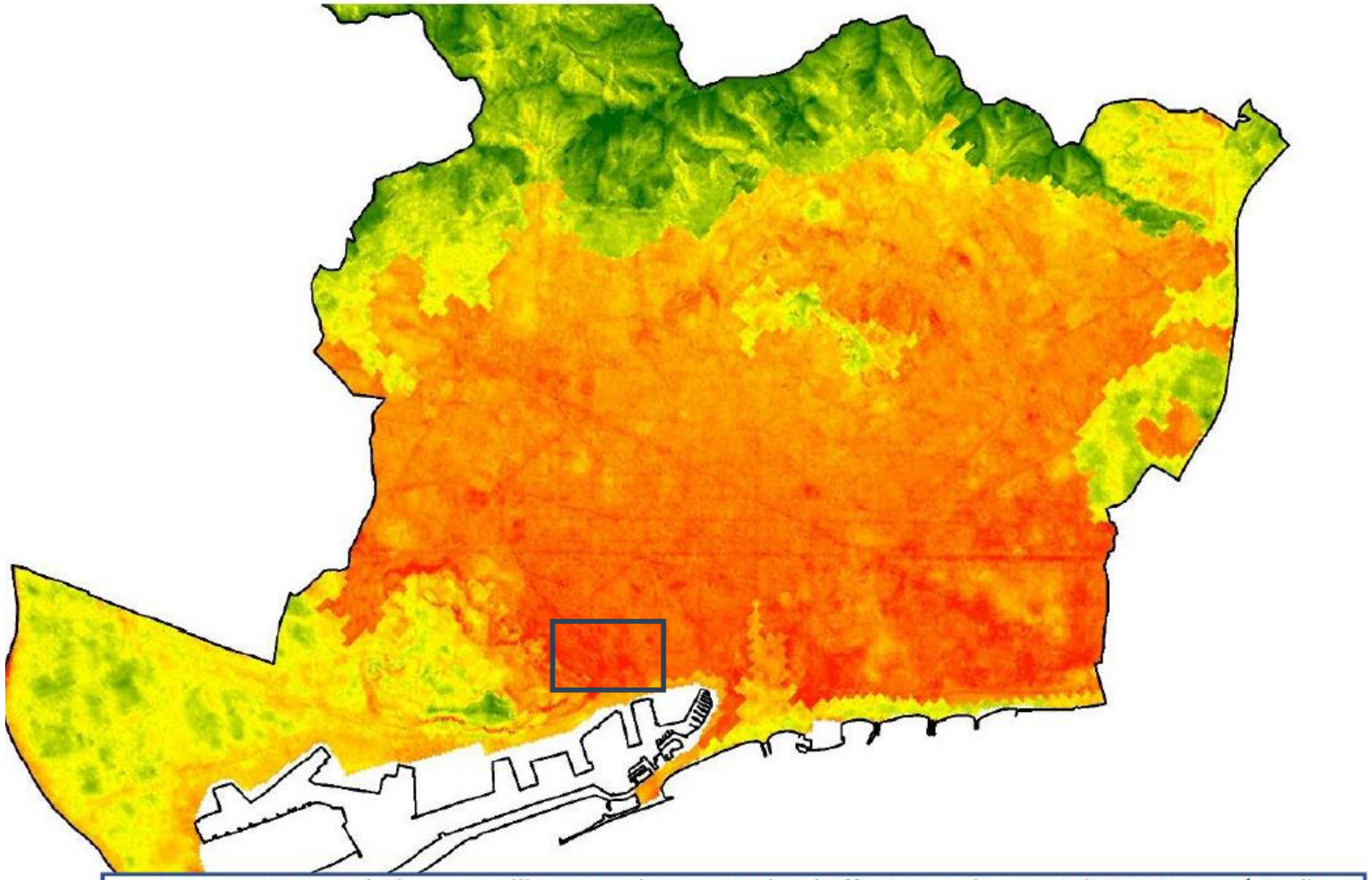
T=10 YEARS	K=lime-sand-gravel subsoil=0,00001	C=0,9	(worst of the cases)							DEPO (M3)	2.000,00
Duration (min)	Intensity (mm/h)	C	K	Area Sector(m2)	A Wsuds (m2)	Q rain (m3/seg)	Rain Volume (m3)	Q infiltrated (m3/seg)	Vfiltrated (m3)	Vnot filtrated (m3)	V accumulated (m3)	V overflow to the rainwater harvesting system (m3)
5	9,95	0,9	0,00001	478.174,39	123.041,66	1,19	356,84	1,23	369,12	0,00	0,00	0,00
10	23,41	0,9	0,00001	478.174,39	123.041,66	2,80	839,55	1,23	369,12	470,43	470,43	0,00
15	45	0,9	0,00001	478.174,39	123.041,66	5,38	1.613,84	1,23	369,12	1.244,71	1.715,14	0,00
20	136,02	0,9	0,00001	478.174,39	123.041,66	16,26	4.878,10	1,23	369,12	4.508,97	2.000,00	4.224,11
25	183,22	0,9	0,00001	478.174,39	123.041,66	21,90	6.570,83	1,23	369,12	6.201,71	2.000,00	6.201,71
30	74,9	0,9	0,00001	478.174,39	123.041,66	8,95	2.686,14	1,23	369,12	2.317,02	2.000,00	2.317,02
35	67,57	0,9	0,00001	478.174,39	123.041,66	8,08	2.423,27	1,23	369,12	2.054,14	2.000,00	2.054,14
40	38,47	0,9	0,00001	478.174,39	123.041,66	4,60	1.379,65	1,23	369,12	1.010,53	2.000,00	1.010,53
45	22,44	0,9	0,00001	478.174,39	123.041,66	2,68	804,77	1,23	369,12	435,64	2.000,00	435,64
50	18	0,9	0,00001	478.174,39	123.041,66	2,15	645,54	1,23	369,12	276,41	2.000,00	276,41
55	5,57	0,9	0,00001	478.174,39	123.041,66	0,67	199,76	1,23	369,12	0,00	2.000,00	0,00
60	4,44	0,9	0,00001	478.174,39	123.041,66	0,53	159,23	1,23	369,12	0,00	2.000,00	0,00
65	3,94	0,9	0,00001	478.174,39	123.041,66	0,47	141,30	1,23	369,12	0,00	2.000,00	0,00
70	3,67	0,9	0,00001	478.174,39	123.041,66	0,44	131,62	1,23	369,12	0,00	2.000,00	0,00
							22.830,44		5.167,75	18.519,57	2.000,00	16.519,57



Own source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

3.SURFACES TEMPERATURES REDUCTION: Raval is inside the Barcelona Heat Island effect.



Dr.Josep Roca and Blanca Arelllano EGU'20 Heat Island Effect Barcelona LST (MODIS 30m/pixel)

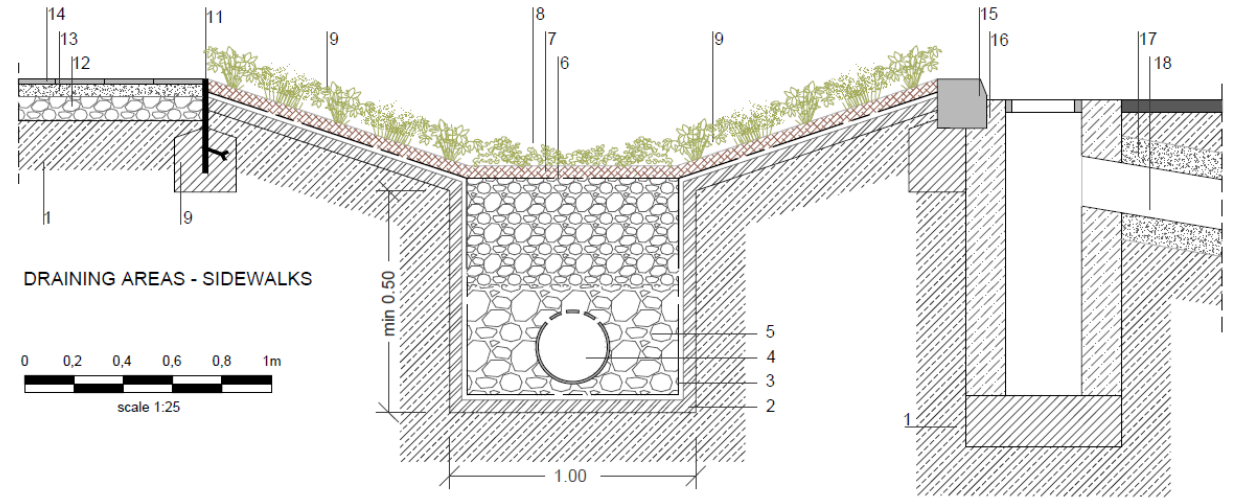
In the context of global climate change, not all the materials and construction systems are the proper ones. This part is mainly experimental and has taken almost three years measuring surface temperatures of some WSUDs in Barcelona and treating its data to stablish a criteria to choose WSUDs which can help to reduce surface temperatures, even in some cases, underneath the environmental temperatures. It means we can produce a better thermal effect while planning and implementing the WSUDs in Barcelona and in homoclimatic cities. Hereby we present some examples .

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

3.SURFACES TEMPERATURES REDUCTION:

green areas Surface temperatures are always below the environmental ones in summer (2-8ºC); especially after raining.



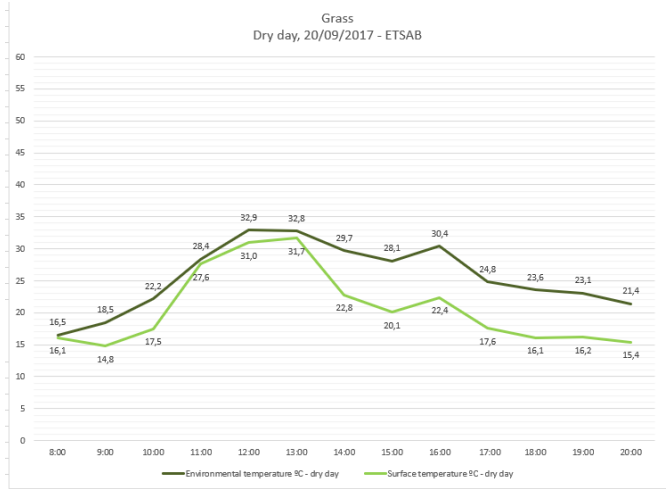
Lotus corniculatus

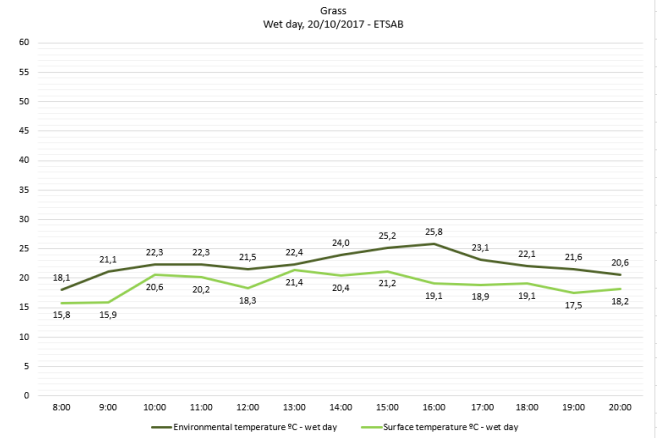
Lotus creticus

Muehlenbeckie complexa

1. COMPTACTED SOIL
2. BENTONITE 5cm
3. ANTI- PRICK GEOTEXTILE 2mm
4. DRAINAGE PIPE Ø30cm
5. GRAVEL 20-40mm
6. ANTI-PRICK GEOTEXTILE 2mm
7. SUSTRATUM
8. VEGETATION: Muehlenbeckie complexa
9. VEGETATION: Lous corniculatus i Lotus creticus
10. CONCRETE BASE
11. METAL PLATE
12. GRAVEL 10cm
13. SAND 5cm
14. PANOT CONCRETE TILE 2cm
15. GRANITO
16. BRICK
17. SAND
18. PIPE

Own source



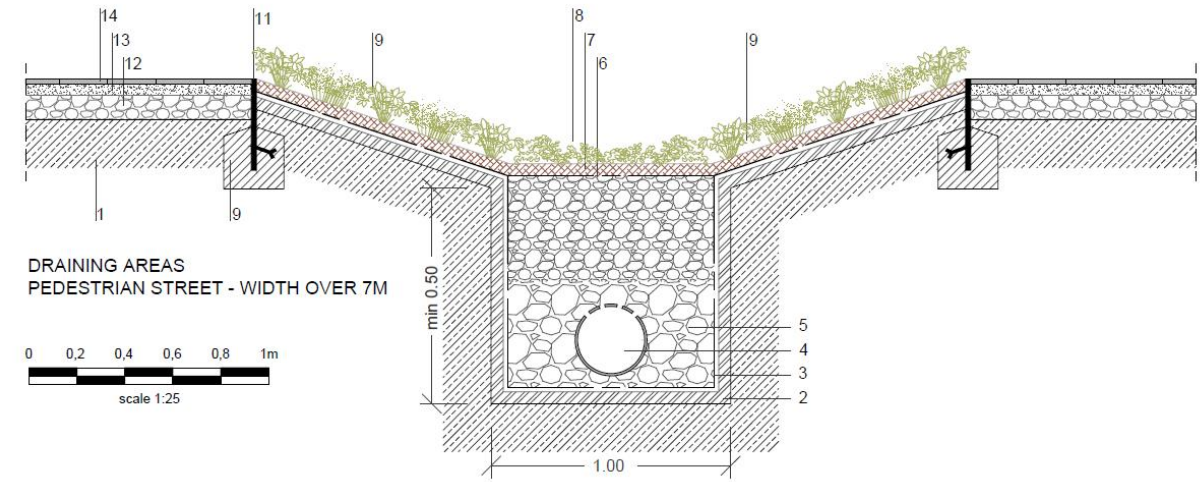


Own source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

3.SURFACES TEMPERATURES REDUCTION: green areas Surface temperaturas are always below the environmental ones in summer; especially after raining.



1. COMPTACTED SOIL
2. BENTONITE 5cm
3. ANTI- PRICK GEOTEXTILE 2mm
4. DRAINAGE PIPE Ø30cm
5. GRAVEL 20-40mm
6. ANTI-PRICK GEOTEXTILE 2mm
7. SUSTRATUM
8. VEGETATION: Muehlenbeckie complexa
9. VEGETATION: Lous corniculatus i Lotus creticus
10. CONCRETE BASE
11. METAL PLATE
12. GRAVEL 10cm
13. SAND 5cm
14. PANOT CONCRETE TILE 2cm

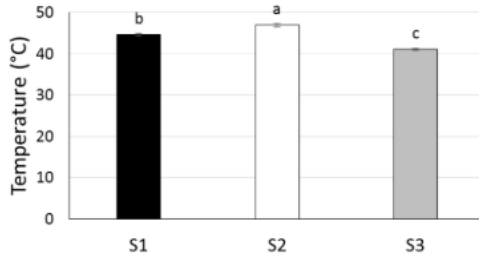
Own source

SUBSTRATES TEMPERATURES:

S1= 70% brick, 10%sand, 20%coconut fiber;

S2=70% brick, 10%thick sand and 20% compost;

S3= 70% commercial substrate (natural pozzolans and expanded clay at a 50%) and a 30% f poeat: ***CHOSEN SUBSTRATE.***



S3< 12,76% S1

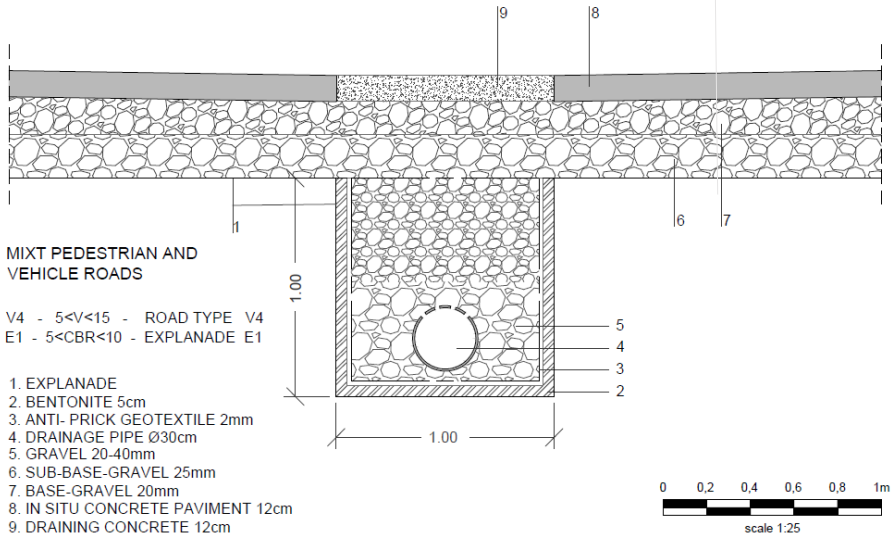
S3< 8,88% S2

"Estudio del comportamiento de sustratos para su uso como cubierta ecológica en el Sureste de España" Pedro Valera García. Universidad Politécnica de Cartagena .

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

3.SURFACES TEMPERATURES REDUCTION: draining concrete, as it doesn't retain water it has a fast infiltration but bad surfaces temperatures except when it's in the buildings shade (up to 15ºC less) as it happens in these statistics until the shade desappears (about 15:30-16:00h). Thus, it should be used in narrow streets with a low SVF (skv view factor)

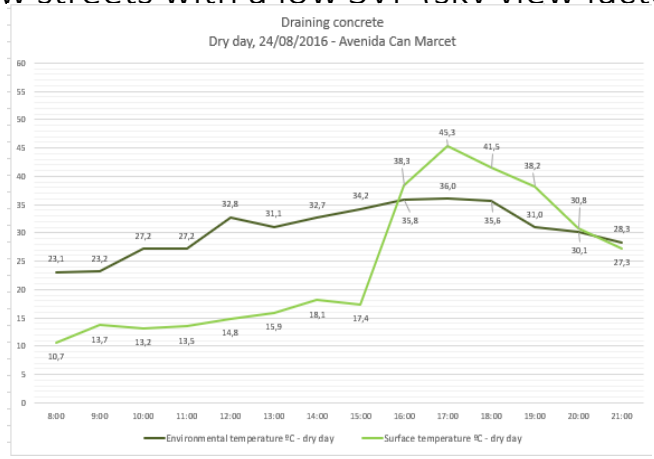


MIXT PEDESTRIAN AND VEHICLE ROADS

V4 - 5<V<15 - ROAD TYPE V4
E1 - 5<CBR<10 - EXPLANADE E1

1. EXPLANADE
2. BENTONITE 5cm
3. ANTI- PRICK GEOTEXTILE 2mm
4. DRAINAGE PIPE Ø30cm
5. GRAVEL 20-40mm
6. SUB-BASE-GRAVEL 25mm
7. BASE-GRAVEL 20mm
8. IN SITU CONCRETE PAVIMENT 12cm
9. DRAINING CONCRETE 12cm

Own source adapting a "Guía Básica de Diseño de Sistemas de Gestión Sostenible de Aguas Pluviales en Zonas Verdes y otros Espacios Libres" by the Madrid Municipality solution to a V4 and E1 to dimension the pavement, base and subbase.



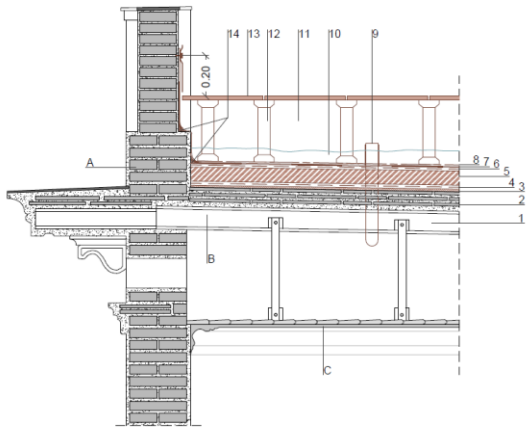
Own source

AMB SVF application source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

3.SURFACES TEMPERATURES REDUCTION: blue roofs, no matter they don't have green surfaces, their Surface temperaturas are always below the environmental ones in summer if they have a little water (2-8ºC); they also have a good termal resistance for the inner spaces below the blue roofs. We spent 2 years measuring a building blue roof , the first year, and the second year an own prototype built at the patio ETSAB. The trend was the same.



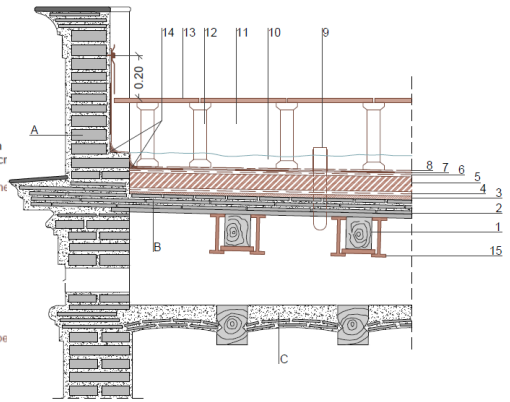
METAL STRUTURE TYPOLOGY - RAVAL
(Phd Thesis by Pere Giol 1995) + BLUE ROOF

A: LOAD BEARING WALL 30cm

B: EXISTING ROOF + BLUE ROOF
1. "NARROW WING" DOUBLE T STEEL BEAM:
Usual dimensions: 130/150;160/50;180/55
Inter-axis 70-90 cm
Length 6,5m
2. BRICK FLOORING VAULT: 2 cm quarry tile, 2 cm of Portland cement mortar, 2cm quarry tile and 2 cr PLAIN CONCRETE above flooring vault
3. PERLITE LEVELING LAYER (cm depending on the slope requirements)
4. GEOTEXTILE 2mm
5. THERMAL ILUSTRATION 7 cm
6. GEOTEXTILE 2 cm
7. IMPERVIOUS MEMBRANE 2mm
8. ANTI-PRICK GEOTEXTILE 2 cm
9. OVERFLOW PIPE 10cm
10. 10cm of maximum level of water
11. VENTILATION AIR CHAMBER 30 cm
12. SELF-REGULATING PYLON
13. ARTIFITIAL STONE 60x40x5cm with 1 cm of ope joint, light sand colors
14. 1/4 CIRCLE OF MORTAR 5x5cm (DB HS1)

C: EXISTING HURDLE FALSE CEILING

Own source adapting new Solutions to Pere Giol's Raval construction systems of his thesis



WOOD BEAMS STRUTURE TYPOLOGY - RAVAL
(Phd Thesis by Pere Giol 1995) + BLUE ROOF

A: LOAD BEARING WALL 30cm

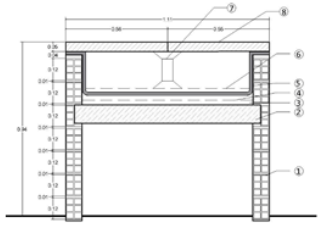
B: EXISTING ROOF + BLUE ROOF
1. WOOD BEAMS:
Usual dimensions 13-14/18-20; 15-16/20-22
Inter-axis;55
Length up to 6,25m
2. BRICK FLOORING VAULT: 2 cm quarry tile, 2 cm of Portland cement mortar, 2cm quarry tile and 2 cm, PLAIN CONCRETE above flooring vault
3. PERLITE LEVELING LAYER (cm depending on the slope requirements)
4. GEOTEXTILE 2mm
5. THERMAL ILUSTRATION 7 cm
6. GEOTEXTILE 2 cm
7. IMPERVIOUS MEMBRANE 2mm
8. ANTI-PRICK GEOTEXTILE 2 cm
9. OVERFLOW PIPE 10cm
10. 10cm of maximum level of water
11. VENTILATION AIR CHAMBER 30 cm
12. SELF-REGULATING PYLON
13. ARTIFITIAL STONE 60x40x5cm with 1 cm of open joint, light sand colors
14. 1/4 CIRCLE OF MORTAR 5x5cm (DB HS1)
15. METAL REINFORCEMENT STRUCTURE

C: EXISTING ROOF: wood beams+brick flooring vaults

0 0,2 0,4 0,6 0,8 1m
scale 1:20

Own source adapting new Solutions to Pere Giol's Raval construction systems of his thesis

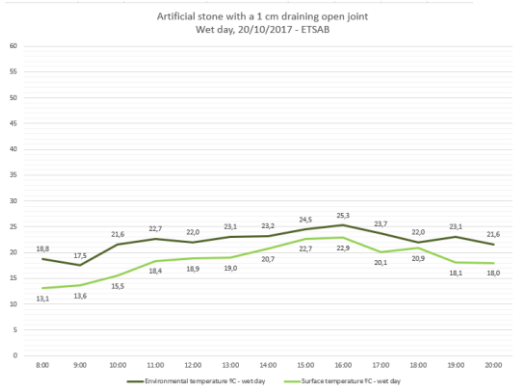
Figure9. **Blue roof prototype**



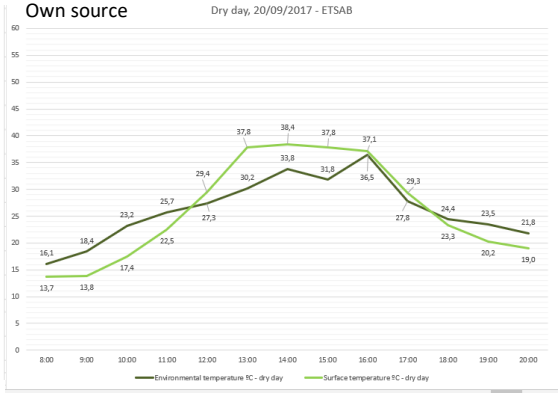
1. Brick wall: 24x1,5 x 9cm.
2. Wood conglomerate resins support 10m.
3. Thermal Isolation: 5cm (according to the norm).
4. Geotextile 2mm.
5. Impervious membrane 2mm.
6. Anti-prick geotextile 2mm.
7. Self-regulating pylon
8. Artificial stone: 5x50cmx50cm.

Ventilated air chamber is 30cm.

Own source



Own source



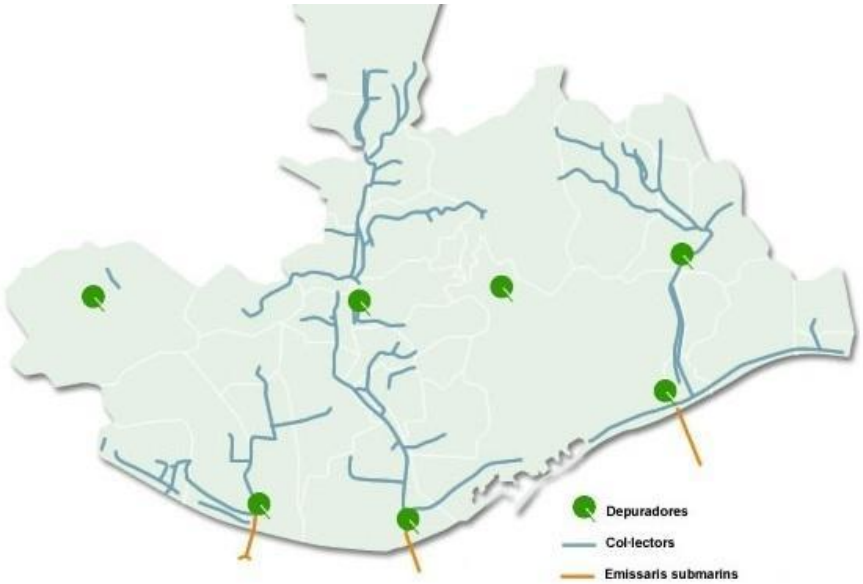
Own source

REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems).

M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

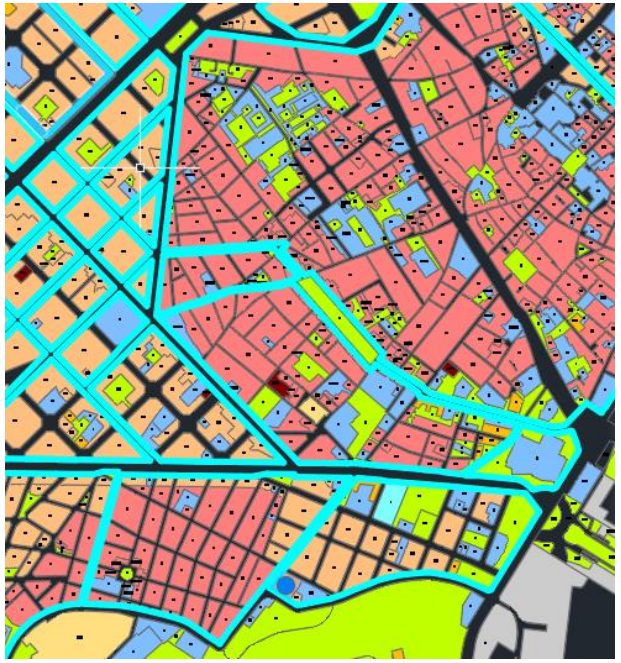
3.WATER QUALITY: this descentralization of the water treatment will save energy by avoiding the transportation a long distance away to the water sewage treatment plants. It also avoids diffusing pollution of the runoff since water quality is not worsened due to its transportation to the depuration plant.

CURRENT WATER TREATMENT PLANTS



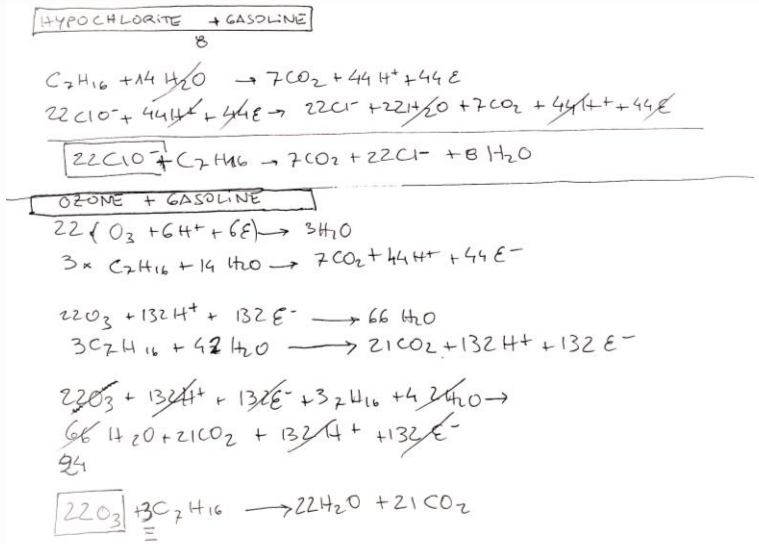
Agbar source:https://www.aiguesdebarcelona.cat/es/web/ab-corporativa/actividades-e-instalaciones

PREVIEWED SUPERISLANDS BY THE BARCELONA MUNICIPALITY, possible harvester units.



Own source redrawn with the Barcelona Municipality information

IN SITU CLEANING SYSTEM TO AVOID THE NON-POINT CONTAMINATION (i.e. MIXT-ROAD-PEDESTRIAN STREETS).



REDUCTION IN WATER CONSUMPTION AND ENVIRONMENTAL IMPROVEMENTS IN BARCELONA THROUGH WSUDs (Water Sensitive Urban Design Systems). M.Pérez Cambra,Phd Candidate, Dr. Martínez Santafé,Maria Dolors,Dr.Roca, Josep.

CONCLUSION:with this wsuds specific urbanistic micro-acupuncture we can mitigate some effects of climate change such as: water scarcity, pluvial floods and heat island effect.

THANK YOU!!

Special thanks to: Dr. Fausto G. Hegardt; Emeritus Professor of Biochemistry and Molecular Biology for his attention to answer and teach me chemical questions and processes which intervene in the WSUDs water cycle which opens a new range of possibilities in the WSUDs constructions. And to the architects' team who have contributed to this research helping me: with the cartography Marta Falcón Colomé for her crucial help to arrive to this deadline. Architect. ETSAB. UPC., specialist in cartography and norms and fire prevention techniques and to Elsa Mampel Vallvé. Architect, ETSAB. UPC. M.Sc in Planificació Territorial per la UAB for her crucial help with GIS ratios calculations and cartography for this research which has allowed us to take decissions about where to harvest water also to Shereen Dabbas, architect and Landscaper (MBLandArch, UPC) for her important help with cartography in GIS and CAD and excel data management for the temperatures study.