

Invited project - Stormwater management - AWARD and CARDIMED

CONE - 2nd Workshop - Training of trainers
ONLINE | 11 of April 2025

Presenter: Fabio Masi

Iris pseudacorus

Introduction and definitions

Sponge cities

Can 'sponge cities' solve China's urban flooding problem?

WADE SHEPARD JULY 28, 2016



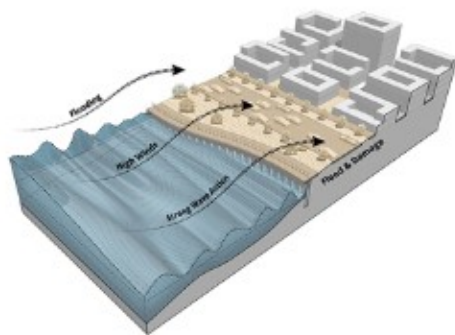
Floods in cities across China this year have caused as much as US\$45 billion worth of damage. (Paul Gonzalez/flickr/cc)



Iris pseudacorus

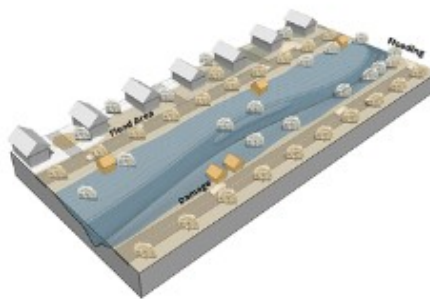
Introduction and definitions

Climate change and floods



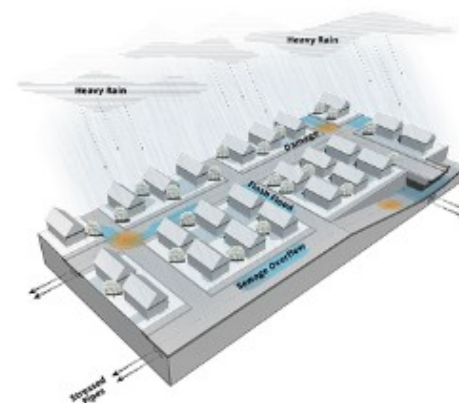
COASTAL FLOODING

Flooding to coastal areas caused by waves / storm surge during a storm



RIVERINE FLOODING

Flooding caused by high river levels



STORMWATER FLOODING

Localized flooding in a community caused by heavy rains

 Naturally **RESILIENT** Communities

[https://
nrcsolutions.org/](https://nrcsolutions.org/)

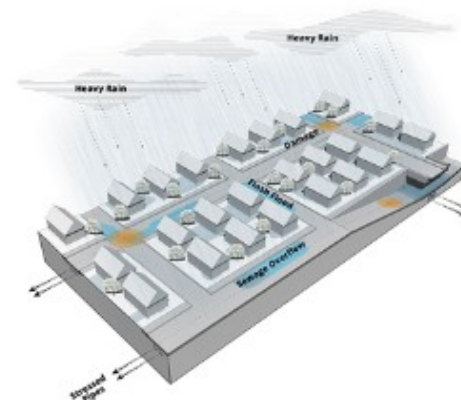
Introduction and definitions

Climate change and floods

- SuDS Sustainable drainage systems
- WSUD Water Sensitive Urban Design
- LID Low impact development
- BMP Best management practices

Urban Water Journal, 2014

<http://dx.doi.org/10.1080/1573062X.2014.916314>



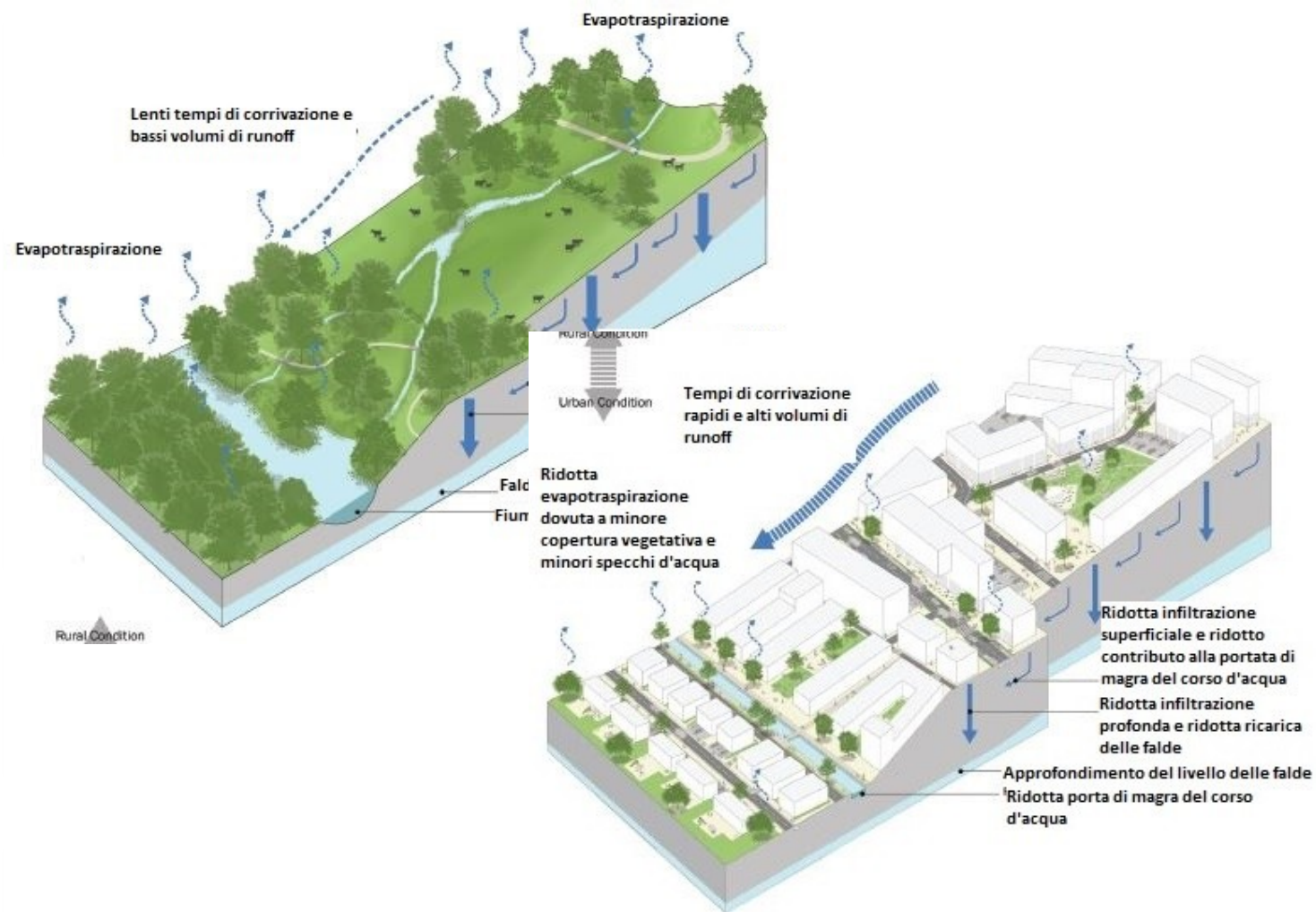
STORMWATER FLOODING

Localized flooding in a community caused by heavy rains

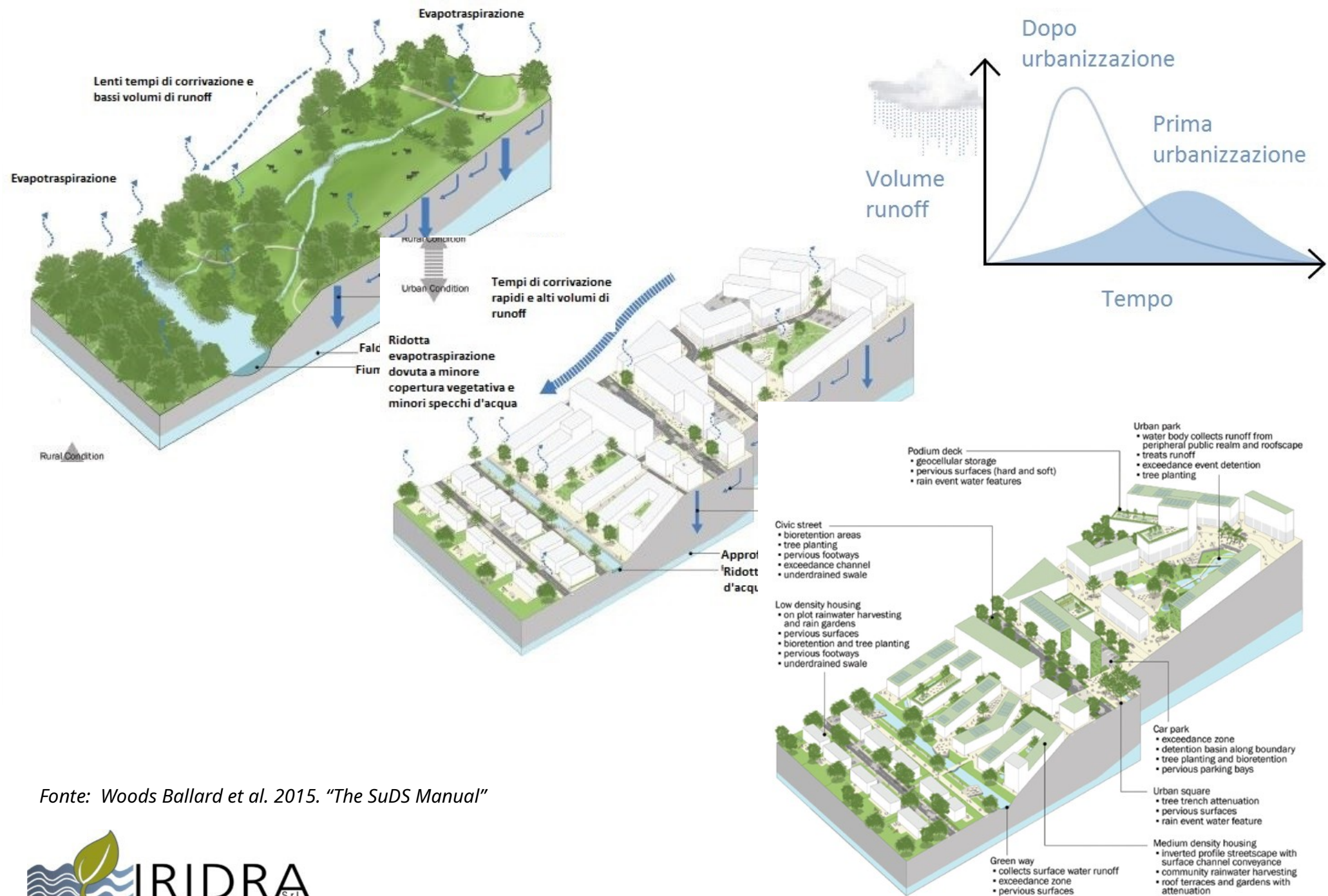
RESEARCH ARTICLE

SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage

Tim D. Fletcher^{a*}, William Shuster^b, William F. Hunt^c, Richard Ashley^d, David Butler^e, Scott Arthur^f, Sam Trowsdale^g, Sylvie Barraud^h, Annette Semadeni-Daviesⁱ, Jean-Luc Bertrand-Krajewski^h, Peter Steen Mikkelsen^j, Gilles Rivard^k, Mathias Uhl^l, Danielle Dagenais^m and Maria Viklanderⁿ



Fonte: Woods Ballard et al. 2015. "The SuDS Manual"



Fonte: Woods Ballard et al. 2015. "The SuDS Manual"

Diffuse pollution in urban areas – Which pollutants?

Monitoring protocols
Sensors

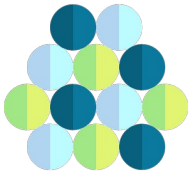
Emerging



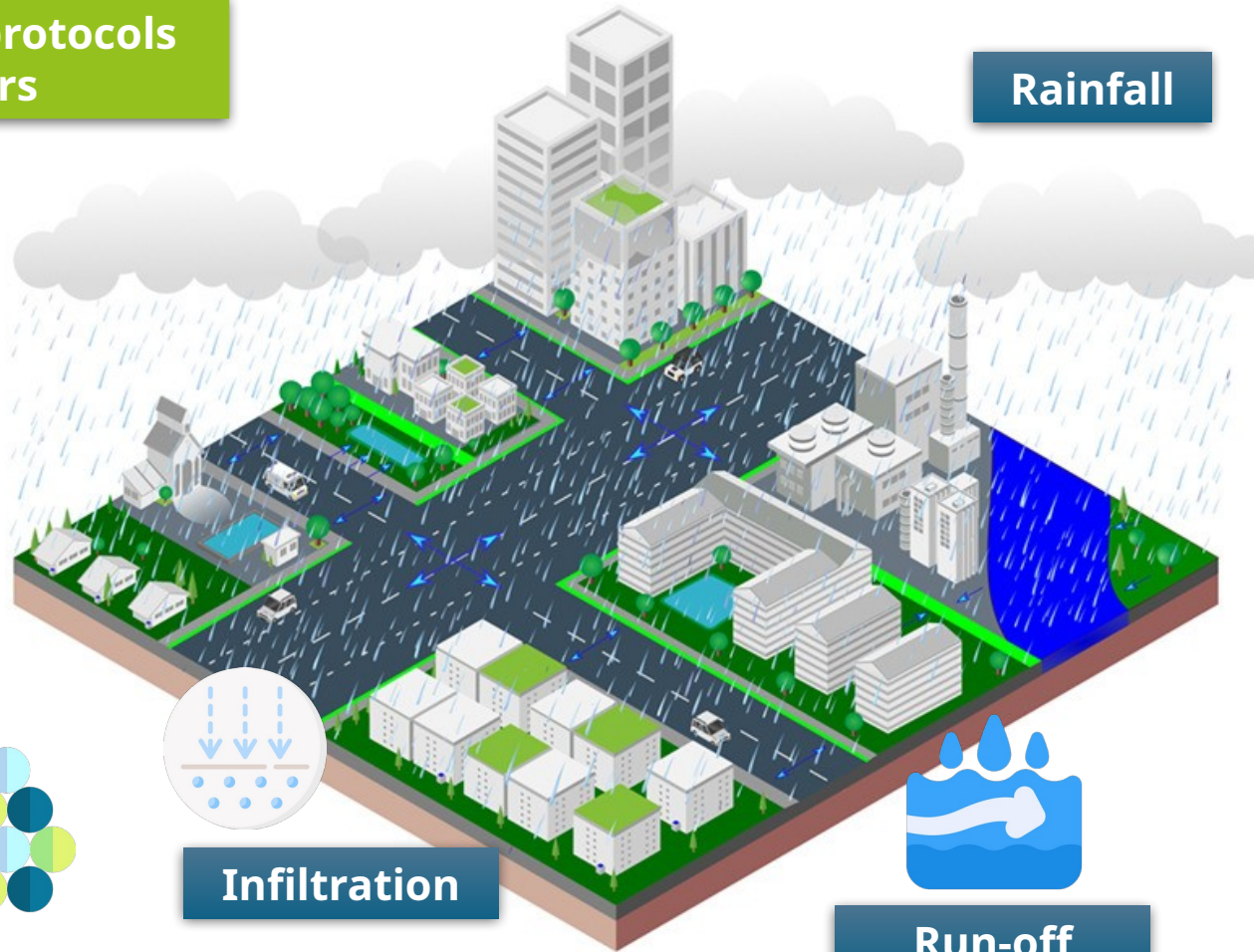
Nutrients (N,



Solids

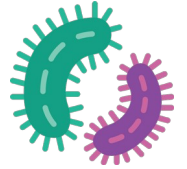


<https://doi.org/10.1002/wat2.1525>

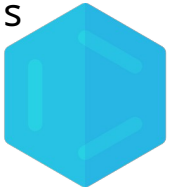


Rainfall

Pathogens



PAHs



Heavy metals



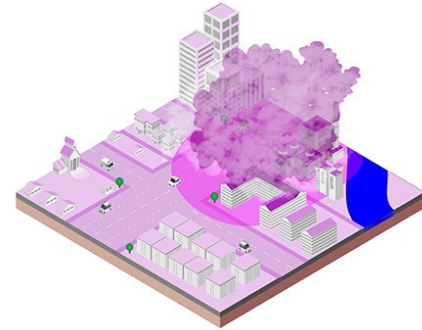
Run-off



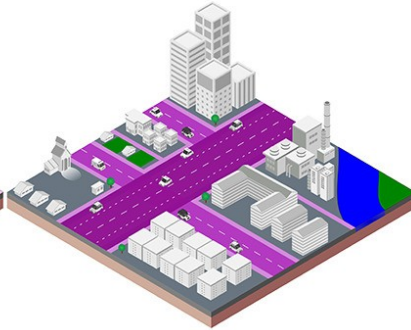
Microplastics

Diffuse pollution in urban areas – Which sources?

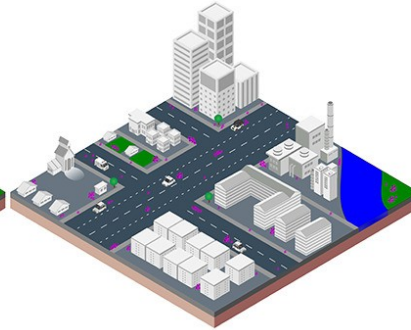
(a) Atmospheric depositions



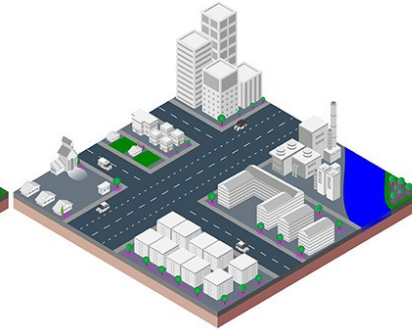
(b) Street pollution due to cars



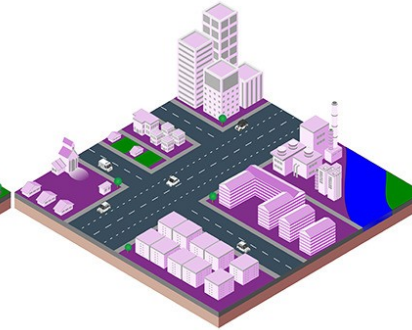
(c) Spot pollution



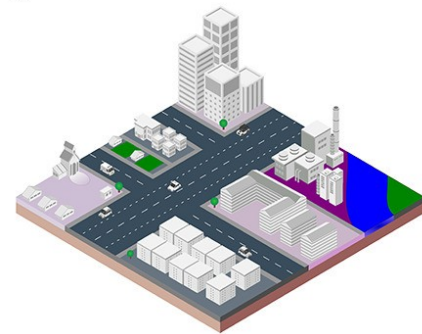
(d) Organic litter



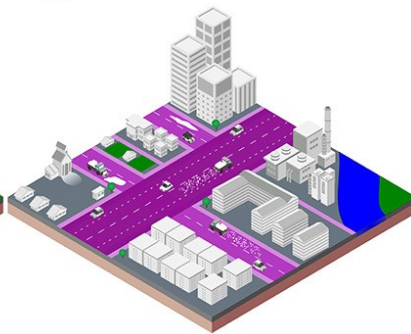
(e) Abrasive sources



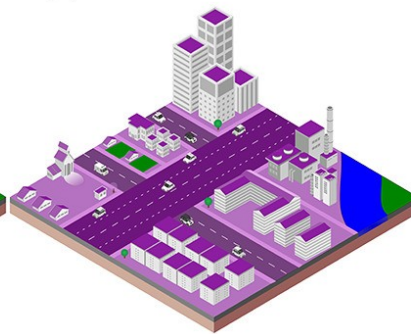
(f) Background pollution of urban soils



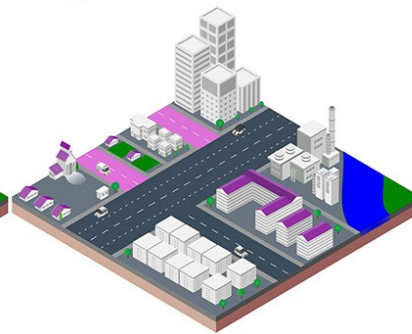
(g) Street cleaning, salt application



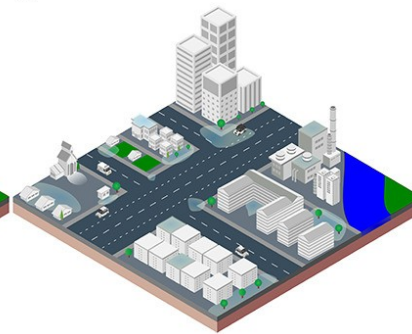
(h) Degree and type of sealing



(i) Slope



(j) Antecedent moisture patterns

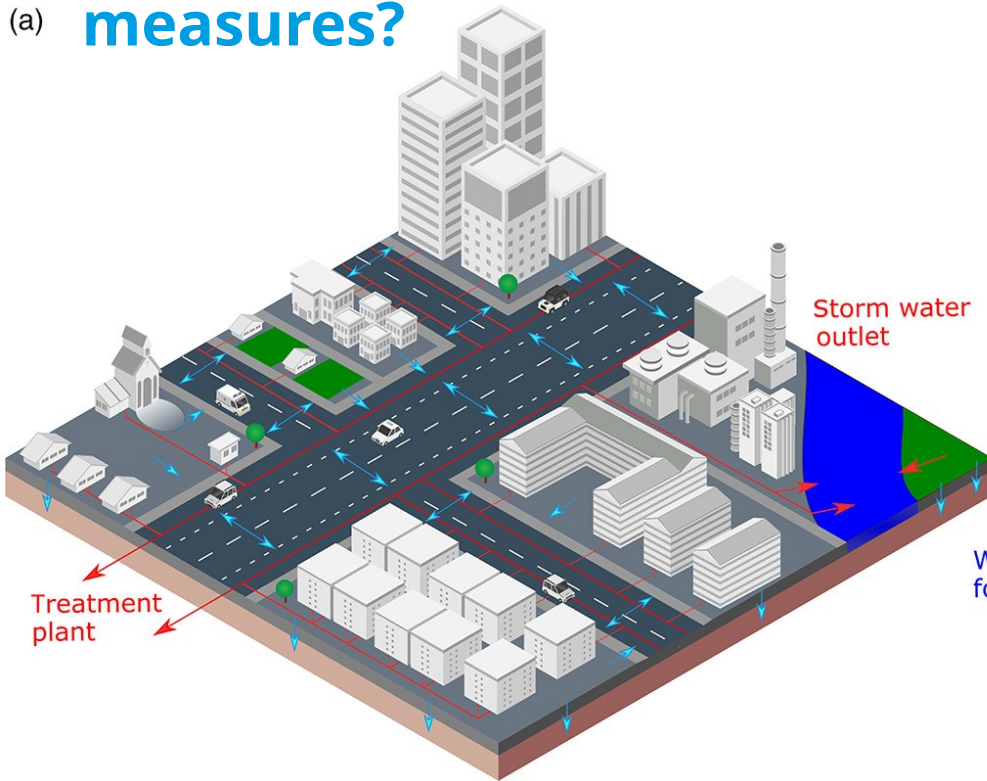


Modelling tool for identification of sources of pollutants

<https://doi.org/10.1002/wat2.1525>

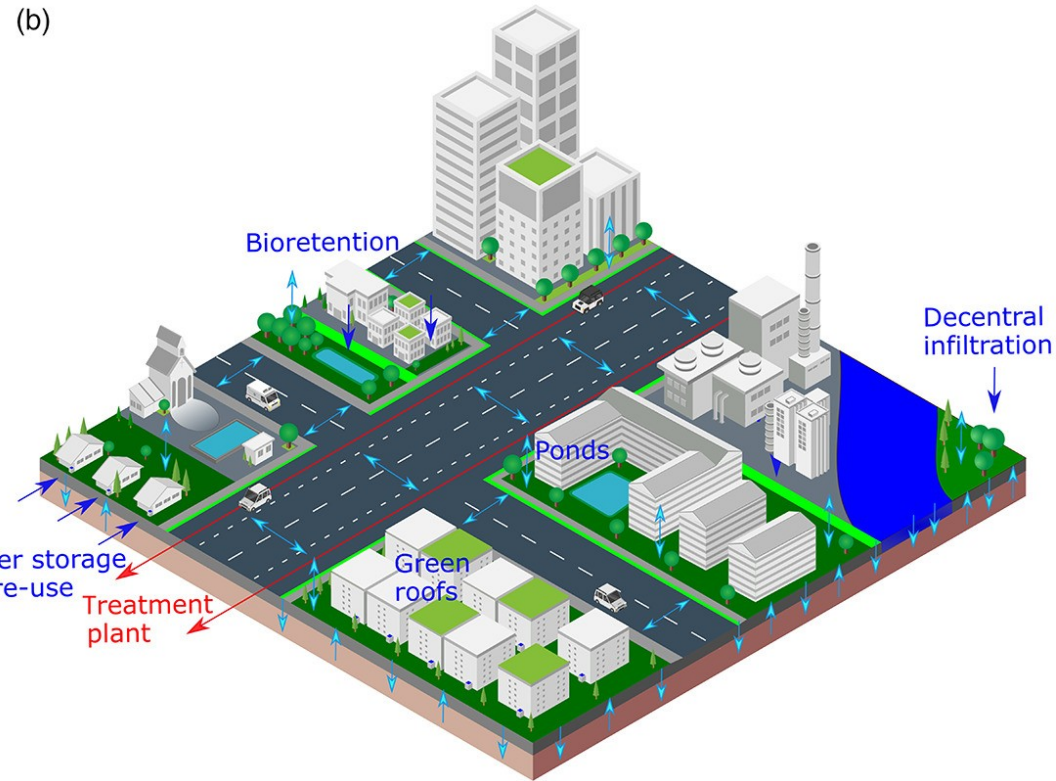
Diffuse pollution in urban areas – Which prevention & Mitigation measures?

(a)



Current situation

(b)



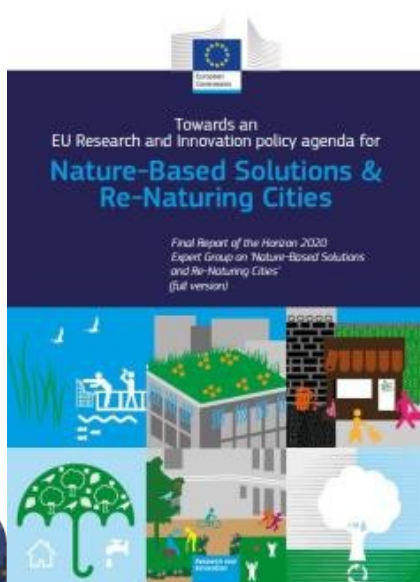
**Use of Blue & Green infrastructures
Modelling and planning tools
DSS based on risks for water reuse**

<https://doi.org/10.1002/wat2.1525>

Introduction and definitions

Nature-based solutions

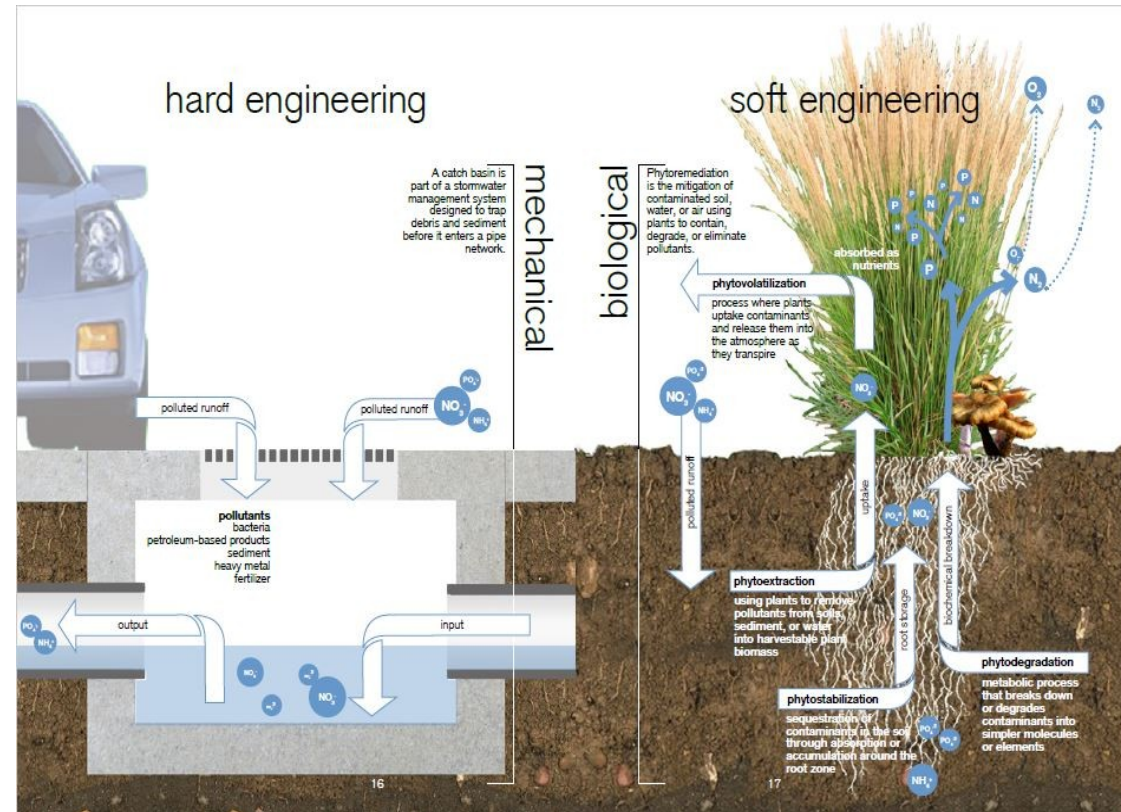
*“The Commission defines **nature-based solutions** as. “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience.”*



Introduction and definitions

Hard engineering vS Soft engineering

1. Atmospheric regulation
2. Climate regulation
3. Water regulation
4. Water supply
5. Erosion control and sediment retentioni
6. Soil formation
7. Nutrient cyclngi
8. Stormwater treatmenti
9. Pollination
10. Biodiversity support
11. Biomass production
12. Recreation
13. Environmental education



Source: Huber, J., 2010. Low Impact

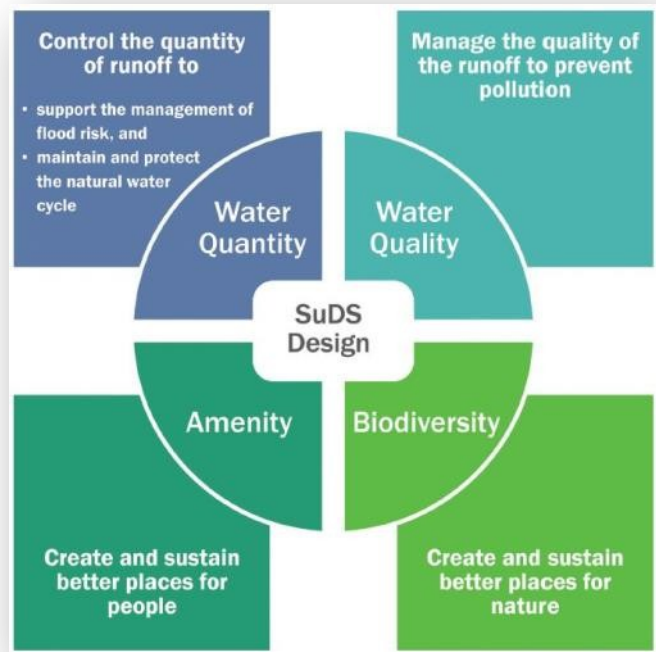
Development: a Design Manual for Urban Areas

Introduction and definitions

Mutiopurpose design

TABLE 7.1 SuDS component delivery of design criteria

Component type	Description	Collection mechanism	Design criteria					
			Water quantity (Chapter 3)			Water quality (Chapter 4)	Amenity (Chapter 5)	Biodiversity (Chapter 6)
			Peak runoff rate	Runoff volumes				
				Small events (Interceptions)	Large events			
Rainwater harvesting systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●	
Green roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●
Infiltration systems	Systems that collect and store runoff, allowing it to infiltrate into the ground	P	●	●	●	●	●	●
Proprietary treatment systems	Subsurface structures designed to provide treatment of runoff	P				●		
Filter strips	Grass strips that promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○
Filter drains	Shallow stone-filled trenches that provide attenuation, conveyance and treatment of runoff	L	●	○		●	○	○
Swales	Vegetated channels (sometimes planted) used to convey and treat runoff	L	●	●	●	●	●	●
Bioretention systems	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	P	●	●	●	●	●	●
Trees	Trees within soil-filled tree pits, tree planters or structural soils used to collect, store and treat runoff	P	●	●		●	●	●
Pervious pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○
Attenuation storage tanks	Large, below-ground voided spaces used to temporarily store runoff before infiltration, controlled release or use	P	●					
Detention basins	Vegetated depressions that store and treat runoff	P	●	●		●	●	●
Ponds and wetlands	Permanent pools of water used to facilitate treatment of runoff – runoff can also be stored in an attenuation zone above the pool	P	●			●	●	●

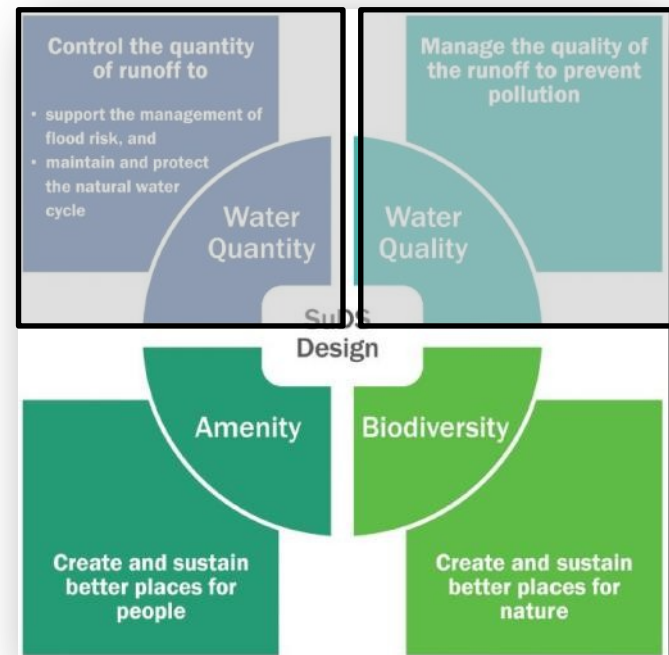


Introduction and definitions

Mutiopurpose design

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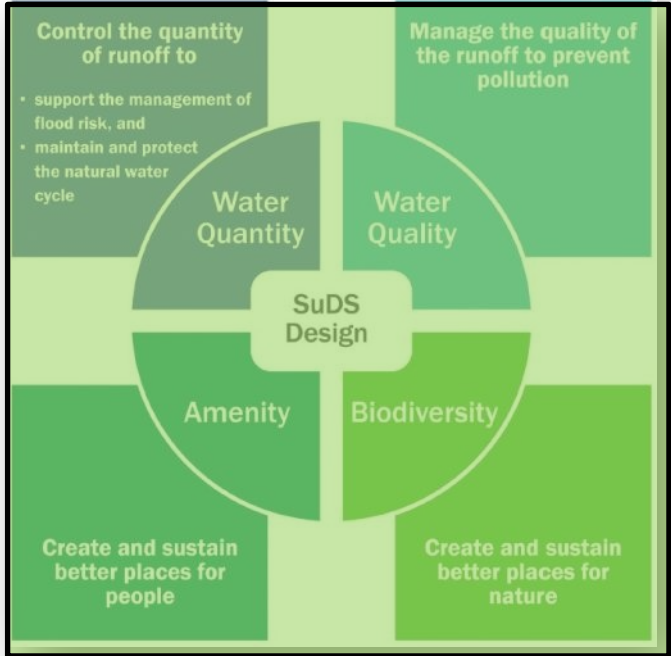


Introduction and definitions

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Iris pseudacorus

IRIDRA: a multidisciplinary team



Nicola Martinuzzi.
Mechanical Engineer



Fabio Masi,
PhD Chemist



Giulio Conte
Biologist



Riccardo Bresciani,
Environmental
Engineer



Ivano Filippini
Land Surveyor



Barbara Bonadies
Architect



Anacleto Rizzo
**Phd Hydraulic
Engineer**



Linda Sabatini
Administration and
Tender



Giordano Fossi
Agronomist



Paolo Armanasco
Agronomist



Kathryn Rivai
Environmental
Engineer



Chiara Sarti
Chemist



Chiara Zurli
Environmental
Engineer



Michela Galletti
Landscape architect



Riccardo Cilia
**Landscape architect
and Codesign expert**



Francesco Leone
Building Engineer



Ilaria Principi
Phd Chemist



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Consulting and Engineering

- Planning
- Feasibility
- Preliminary and Detailed design
- Construction supervision



R&D



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Consulting and Engineering

- **Planning**
- **Feasibility**
- **Preliminary and Detailed design**
- **Construction supervision**



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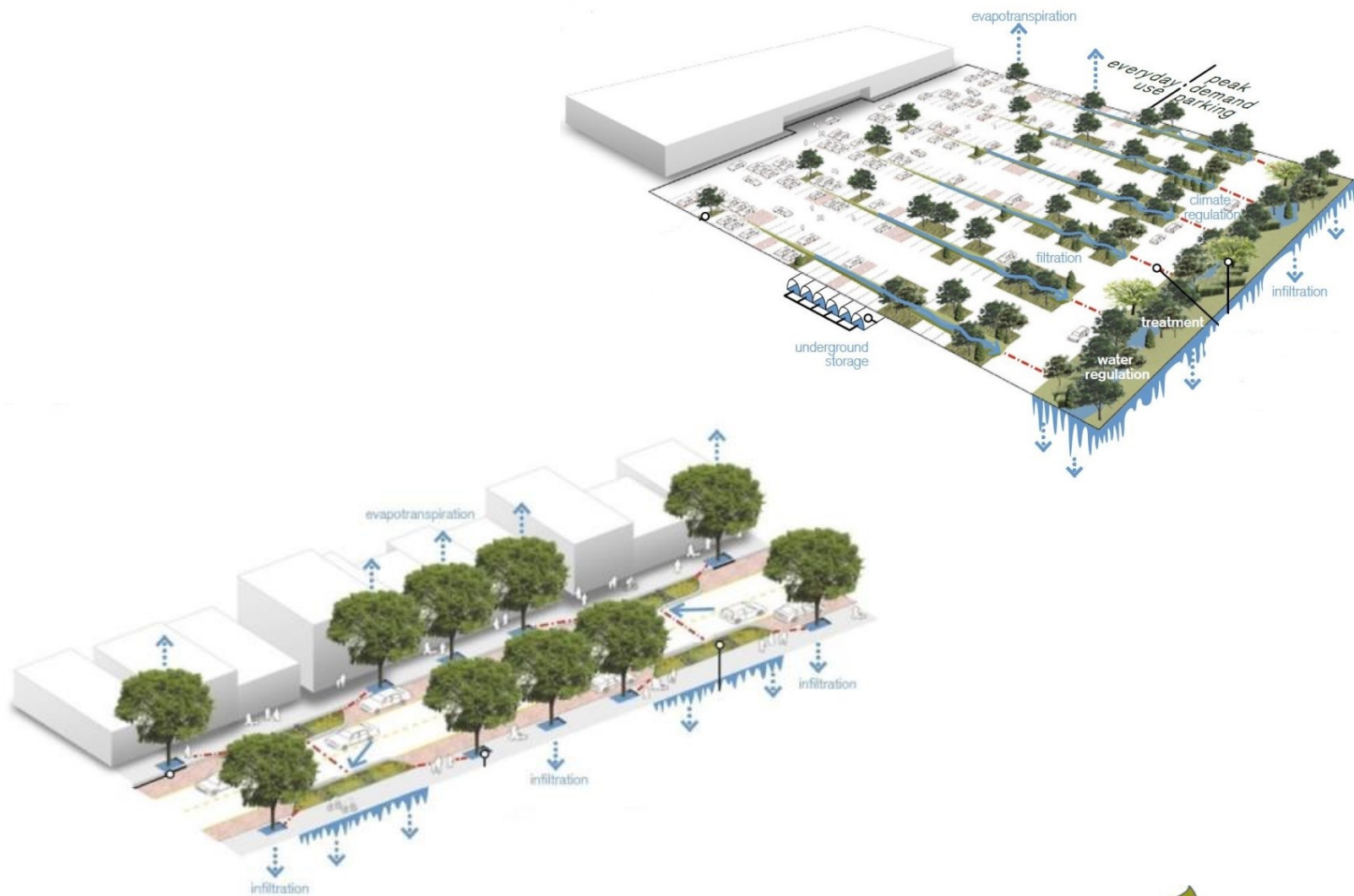
SuDS implementation scales



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SuDS implementation scales

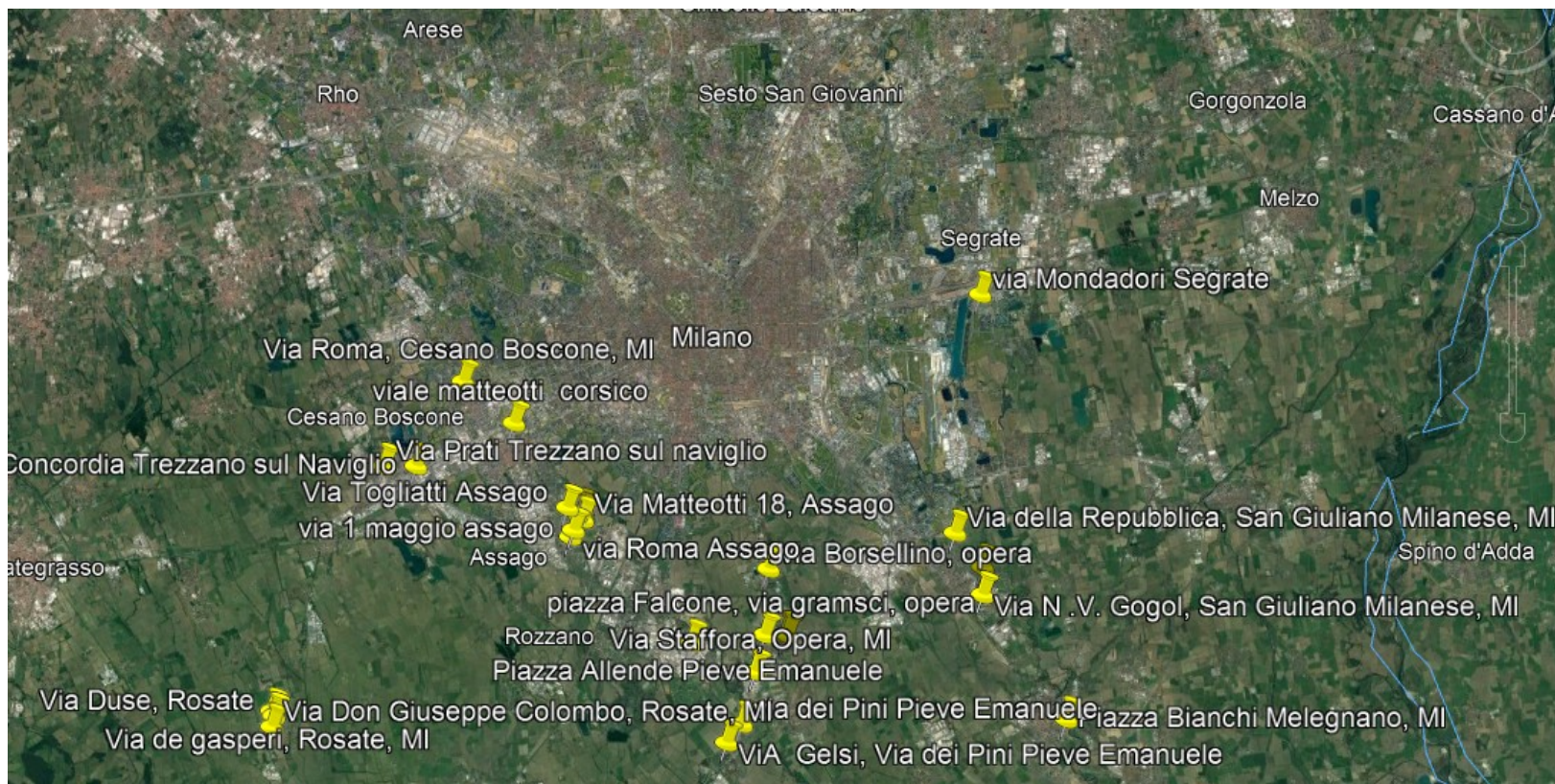
Road and parks



Fonte: Huber, J., 2010. *Low Impact Development: a Design Manual for Urban Areas*

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Metropolitan sponge city of Milan



- PNRR fund, 90 Interventi in 4 lotti progettuali
- Lot 2 (26 interventions. Basic and detailed design IRIDRA – retrofitting SuDS roads and parking lots



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di Milano



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Metropolitan sponge city of Milan

Trezzano sul Naviglio – Via Prati



Pre intervento

Desealing

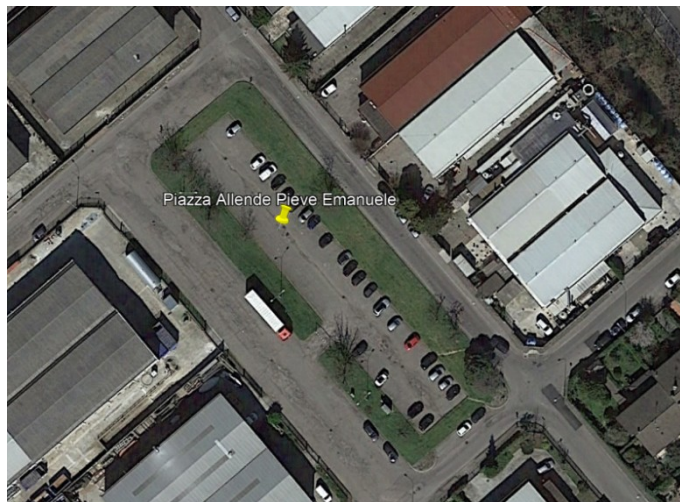
Foto Dicembre 2024



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Metropolitan sponge city of Milan

Pieve Emanuele – Piazza Allende



Pre intervento

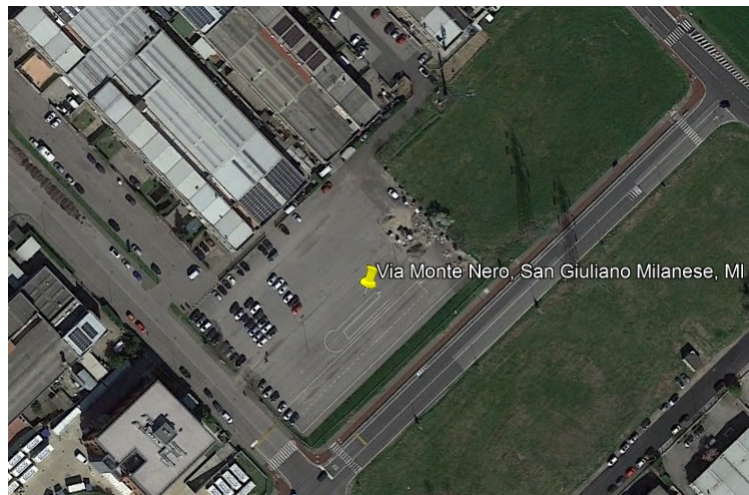
Foto Gennaio 2025



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S. Giuliano Milanese – Via Monte Nero



Pre intervento

Desealing + Bioretention cells

Foto Gennaio 2025



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Viale Kennedy, Varedo (MB)

Pre intervento



Call for Ideas SuDS



Regione
Lombardia

ERSAF
ENTE REGIONALE PER I SERVIZI
ALL'AGRICOLTURA E ALLE FORESTE





**Bioretention cells recovering
space from reduction of
parking lot spaces (not the
number)**

Foto Luglio 2024



Iris pseudacorus

Viale Matteotti, Bovisio Masciago (MB)

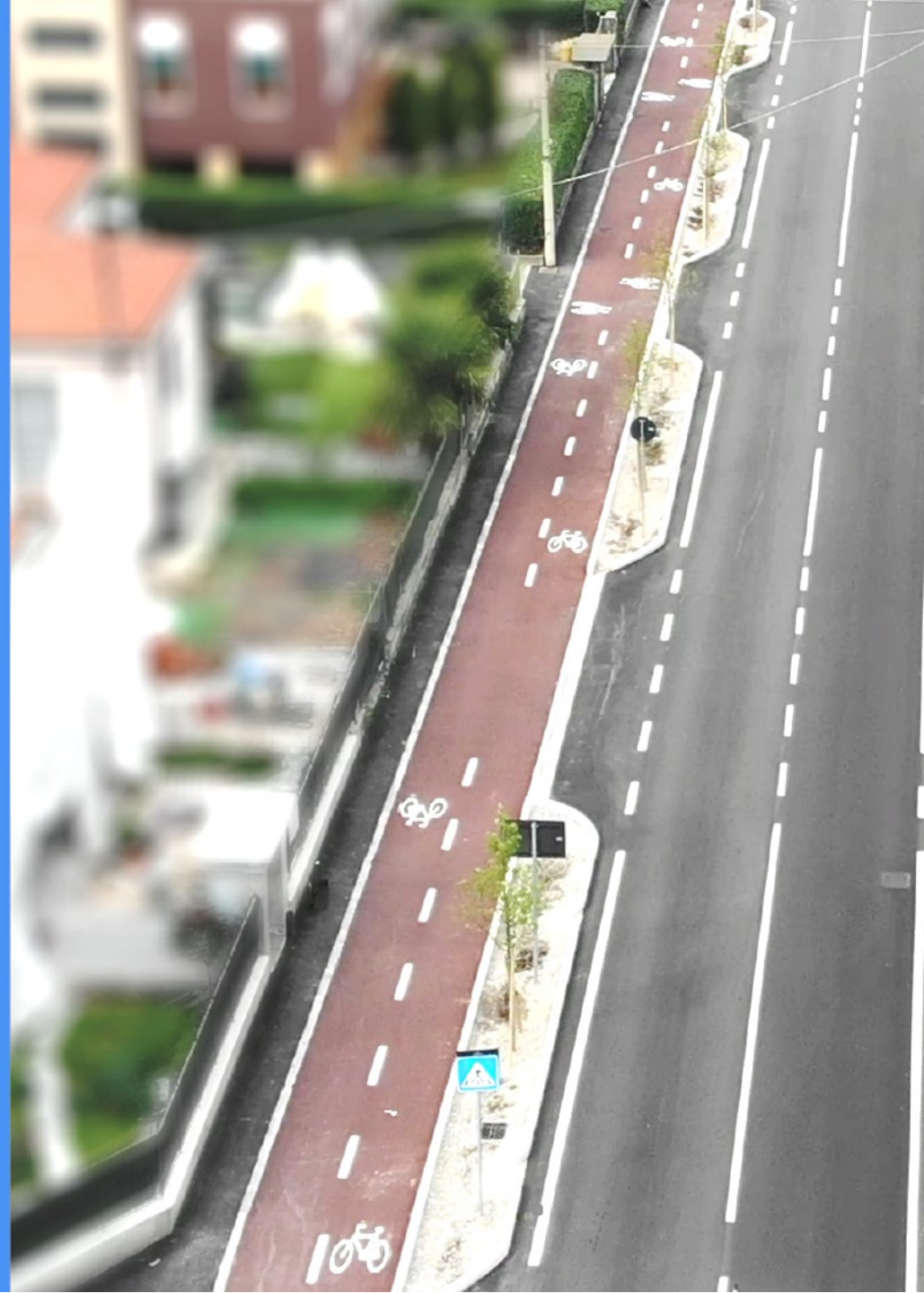


Pre intervento



**Retention cell recovering
space on road**

Foto fine lavori Aprile 2023



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Viale Matteotti, Bovisio Masciago (MB)

SuDS living lab: across street lighting...



Estate 2023



Estate 2024

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Viale Matteotti, Bovisio Masciago (MB)

SuDS living lab: along the road...



Estate 2023



Primavera 2025

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Viale Repubblica, Bovisio Masciago (MB)

After 1 year...



29 Agosto 2023



28 Giugno 2024

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Viale Matteotti, Bovisio Masciago (MB)

SuDS living lab: pedestrian lane



Estate 2023



Primavera 2025

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Viale Matteotti, Bovisio Masciago (MB)

SuDS living lab: crossroads...



Estate 2023



Estate 2024

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Viale Matteotti, Bovisio Masciago (MB)

SuDS living lab: roundabout...

Estate 2023



Primavera 2025

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Via Metastasio, Brescia (BS)



Pre intervento

Bioretention cell recovering space on road

Foto fine lavori Primavera 2024



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SuDS implementation scales

Open space: parks

open space



Slow

Use filter strips at the edge of parks to filter and attenuate stormwater runoff from impervious surfaces during **one to ten-year storm events**. *Filter Strip* pp. 162-163

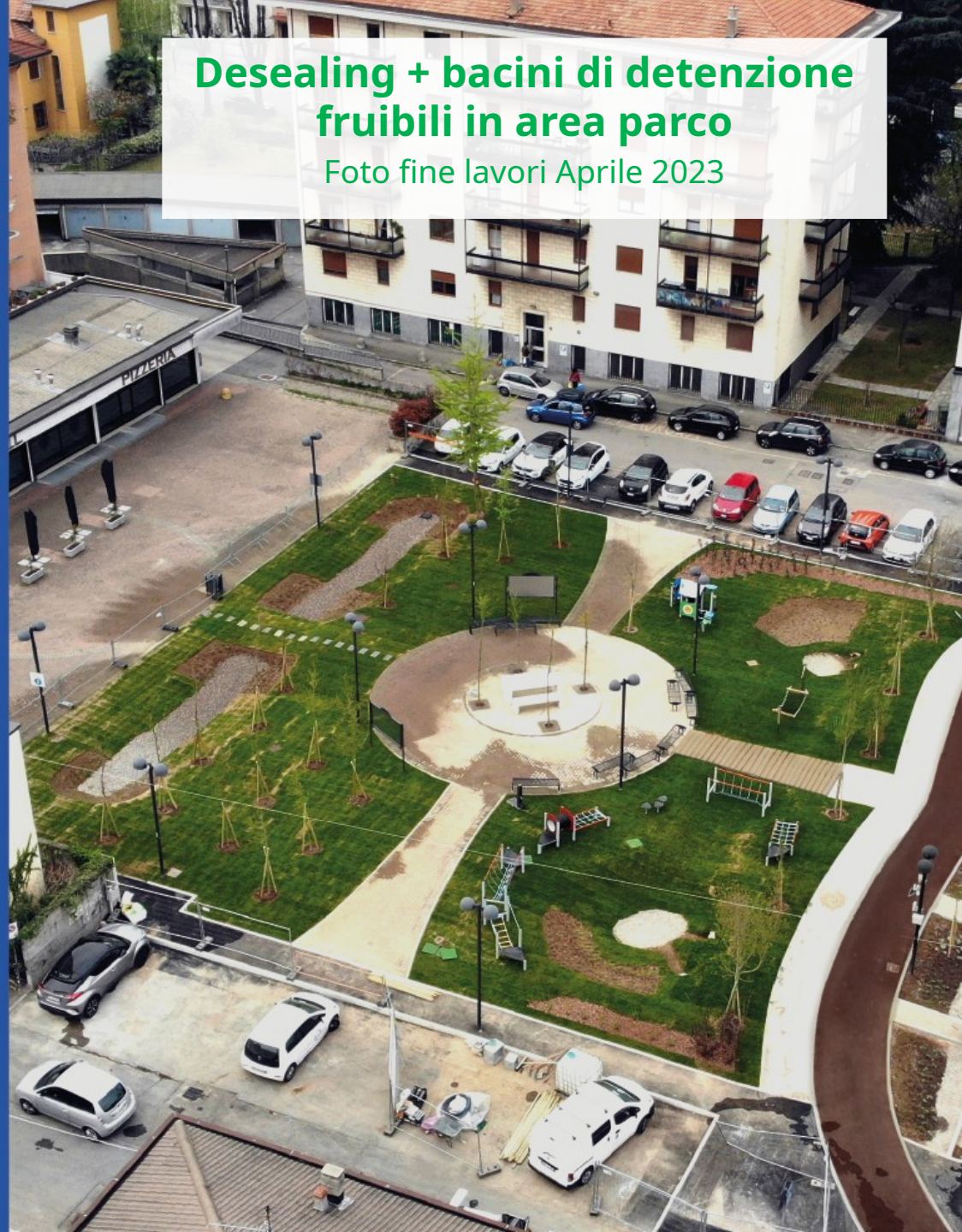
Spread

Use rain gardens as links between filter strips and larger treatment facilities to capture, filter, and infiltrate stormwater runoff from **10 to 25-year storm events**. *Rain Garden* pp. 178-179

Soak

Use infiltration basins and constructed wetlands to treat and infiltrate urban stormwater runoff during **25 to 50-year storm events**. *Constructed Wetland* pp. 186-187

Source: Huber, J., 2010. *Low Impact Development: a Design Manual for Urban Areas*



Desealing + bacini di detenzione fruibili in area parco

Foto fine lavori Aprile 2023

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Viale Matteotti, Bovisio Masciago (MB)

SuDS living lab



Bacini di detenzione e trincee infiltranti



Riqualificazione piazzetta

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Via e Chiesa S. Martino, Carvico (BG)



Pre intervento

Call for Ideas SuDS



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Dry detention basin in park

Novembre 2024



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Parco via Milano, Besozzo (VA)



Call for Ideas SuDS



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**Dry and wet detention basin
in a park**
Novembre 2024

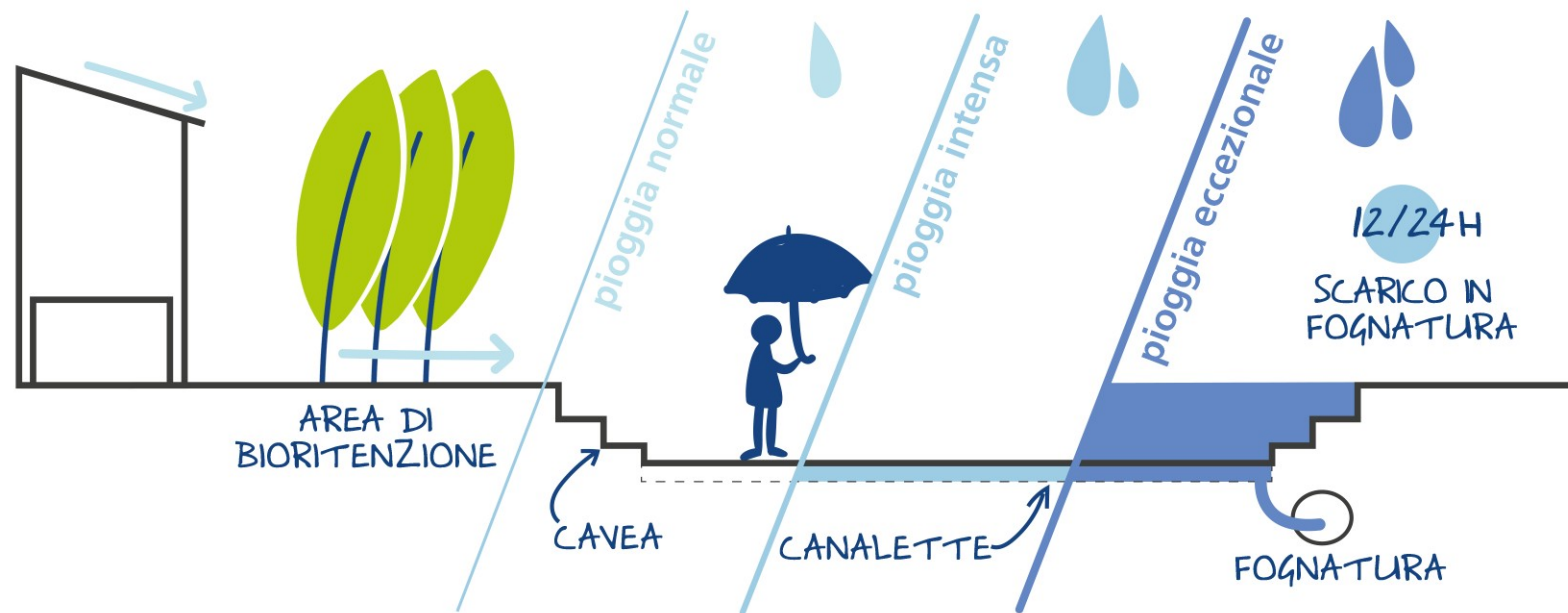
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Water Plaza, Agrate Brianza



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Water Plaza, Agrate Brianza



<https://www.brianzacque.it/it/water-plaza-agrate-brianza>

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Consulting and Engineering

- Planning
- Feasibility
- Preliminary and Detailed design
- Construction supervision



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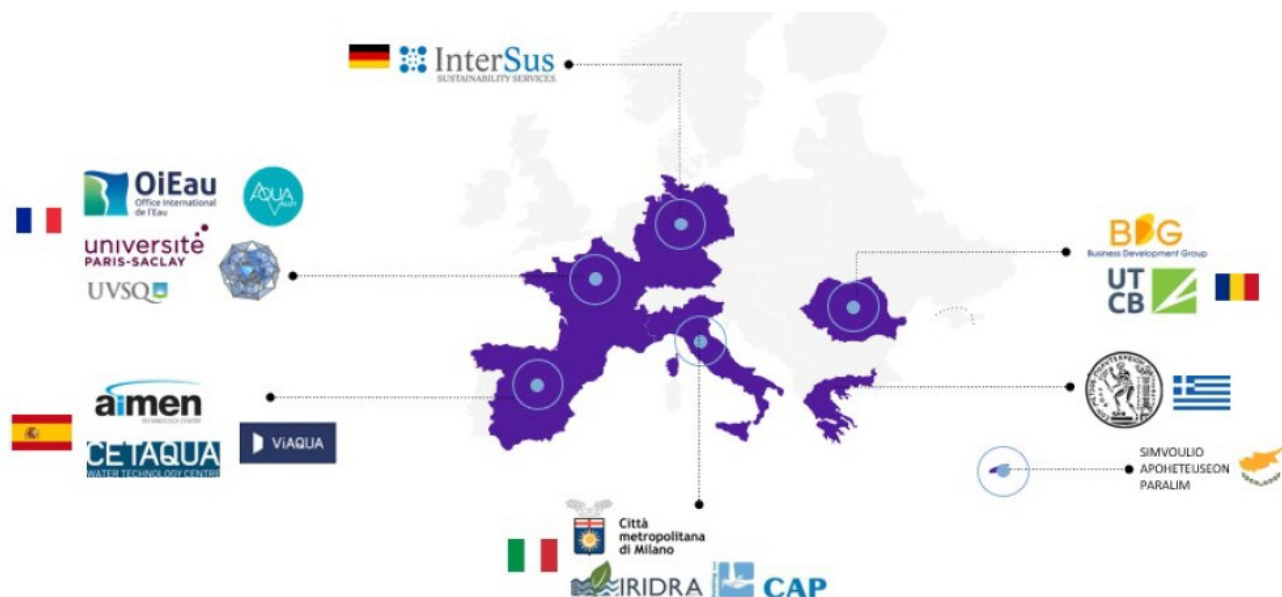
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Funded by
the European Union



SUMMARY IN PICTURES

Main objective provide evidence-based knowledge and lessons learned on the effective integration of affordable, acceptable, and reliable alternative water resources (AWRs) solutions into water supply strategic planning, addressing the impact of global changes. It aims at experimenting AWRs at the local scale in 4 demo cases.



Demo case presentation: Location of CMM

Metropolitan City of Milan



- 133 municipalities
- 1575 kmq



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Demo case presentation: CMM Sponge city

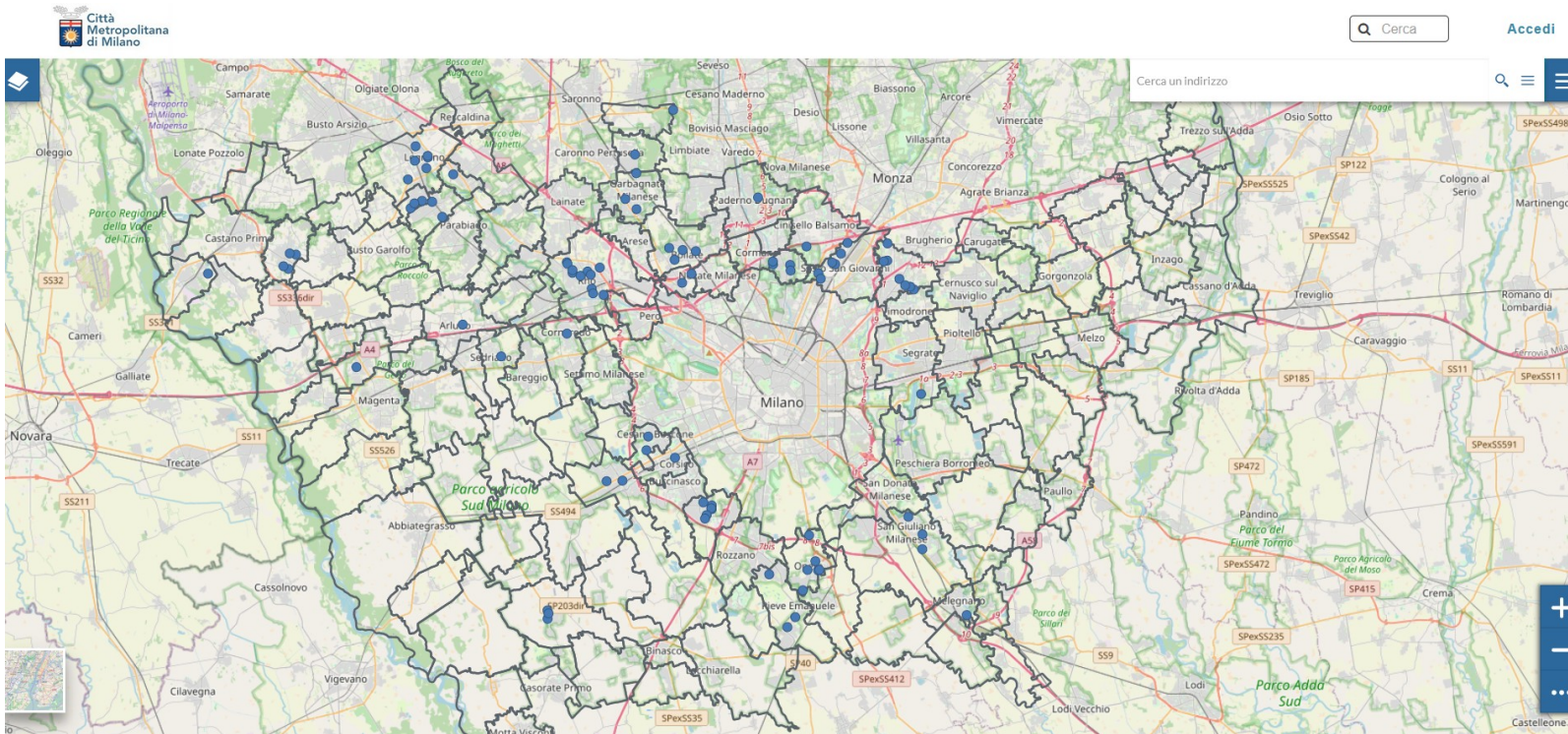


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Metropolitan Sponge City of Milan

- 90 Suds interventions planned and under implementation in 32 Municipalities to study (PNRR (Next Generation EU))

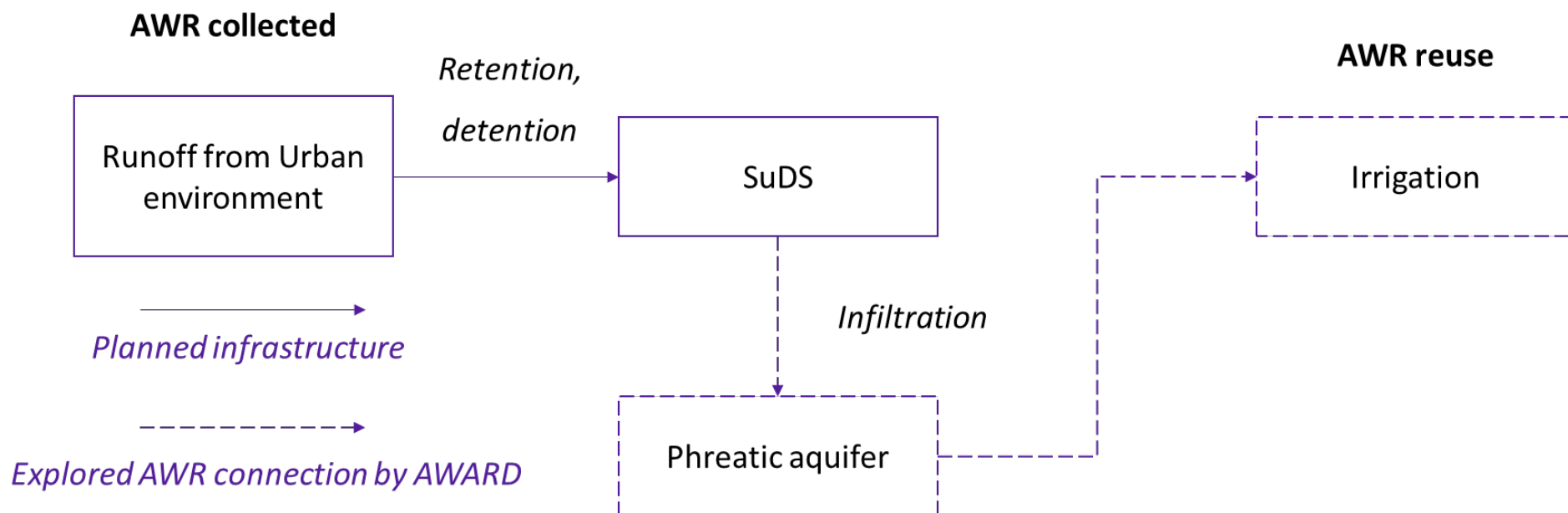


General Assembly (Bucharest) - February 18th 2025

Demo case presentation: CMM Sponge city



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Demo case presentation: Ambition of AWARD

Main issues

- Flooding due to storm water linked to heavy rains.
- Developing the alternative water resources supply systems to recharge directly or indirectly the shallow urban aquifers strata

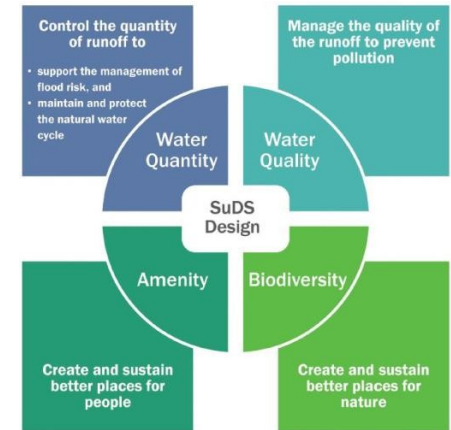
AWR solutions

- Rainwater and storm water collection, treatment
- Aquifer recharge

DEMO monitoring: multipurpose simplified low cost monitoring

- Water quantity: soil moisture + water balance for infiltration estimation (KPI: artificial recharge 5600 m³/y)
- Water quality: pollutant load removal and interception (proxy rainfall) plus monitoring groundwater quality
- Amenity: heat island reduction with low cost temperature sensors (citizen science)
- Biodiversity: low cost approaches (citizen science)

DEMO monitoring (CMM sponge city): estimating impact of sponge city at metropolitan city scale



Source: Woods Ballard et al. 2015. "The SuDS Manual"

Water quantity: Solaro



Control the quantity
of runoff to

- support the management of flood risk, and
- maintain and protect the natural water cycle

Water
Quantity

Sul

SuDS

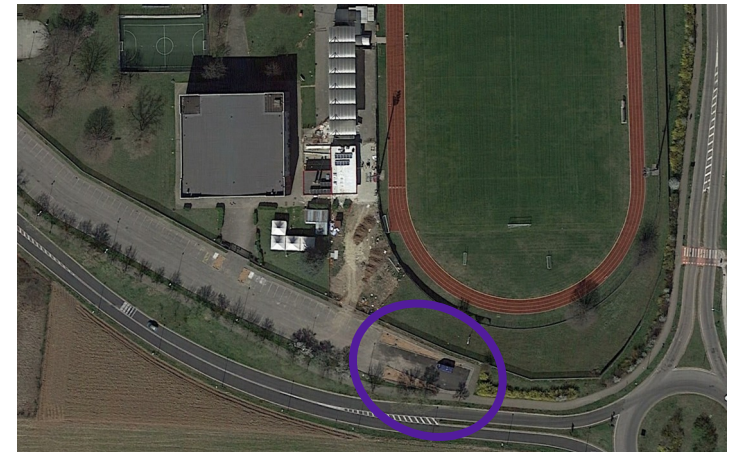
- N° 6 Soakways + Bioretention system of 140 m²

Monitoring

- Collaboration with University of Milan (UniMI)
- N° 1 soil moisture already installed for a Master Thesis of UniMI in collaboration with **CAP**
- N° 1 rain gauge of **CAP**

Steps

- Site visit of **IRIDRA** and UniMI for substituting the SIM and verify the correct functioning of the sensors – **done** on 28/06/2024
- Contract by **IRIDRA** with the external company (Ecosearch) managing the sensors for rehabilitate the remote control – **done**
- Start the data analyses of moisture (sensors of UniMI) and precipitation (rain gauge of CAP) in Autumn 2024 – **ongoing**, start of hydraulic modelling by **CMM**



Water quantity: Solaro



Control the quantity of runoff to

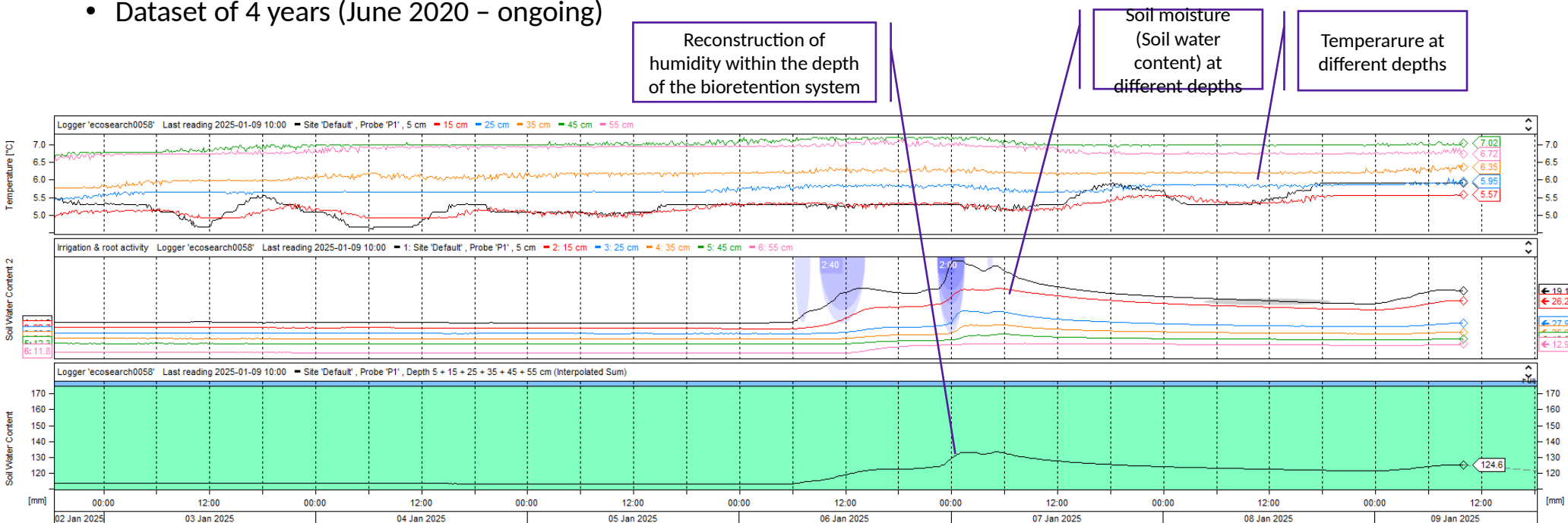
- support the management of flood risk, and
- maintain and protect the natural water cycle

Water Quantity

Sul

No.1 Moisture sensors

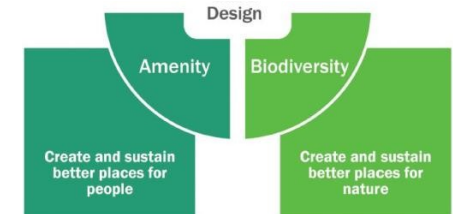
- Humidity, Temperature, and conductivity at three depths (5, 15 and 55 cm)
- Dataset of 4 years (June 2020 – ongoing)



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Amenity and biodiversity: Paderno Dugnano



SuDS

- N° 9 Tree box filter
- N° 1 Bioswale of 280 m²
- N° 1 dry detention basin of 30 m³
- N° 4 soakways

Monitoring

- Amenity (temperature, heat wave) and Biodiversity (e.g. visual inspection) with citizen science

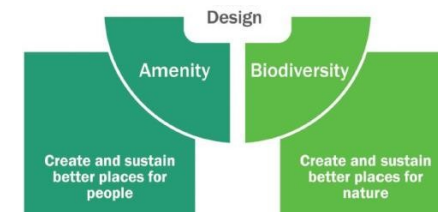
Steps

- Presentation of the AWARD project to the citizens with Local Water Fora (2) – **done**
- Definition of citizen science campaign by **CMM** and **IRIDRA**, including materials and timing – **ongoing**



Amenity and biodiversity: Local Water Fora

DEMO CASE 2 – Pilot: Municipality of Solaro (29th Oct 2024)



Cosa vi ha incuriosito dei temi di questo incontro?

92 responses



120 c.a.

- Middle and High School Students
- Municipal Technicians
- Sports Associations Linked to the Sports Center
- Local Environmental Organizations

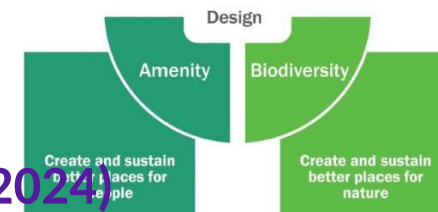


Main Interests around the Meeting

- The Public Administration's Approach in Case of Flooding/Inundation
- Operation of the Parking Lot on Via Berlinguer
- Key/Potential Negative Effects of Choosing NBS Instead of Traditional Interventions
- What NBS Means

Amenity and biodiversity: Local Water Fora

DEMO CASE 2 – Pilot: Municipality of Paderno Dugnano (12nd Dec 2024)





100 c.a.

- Middle School Students
- Municipal Technicians
- Citizens
- Local Environmental Organizations

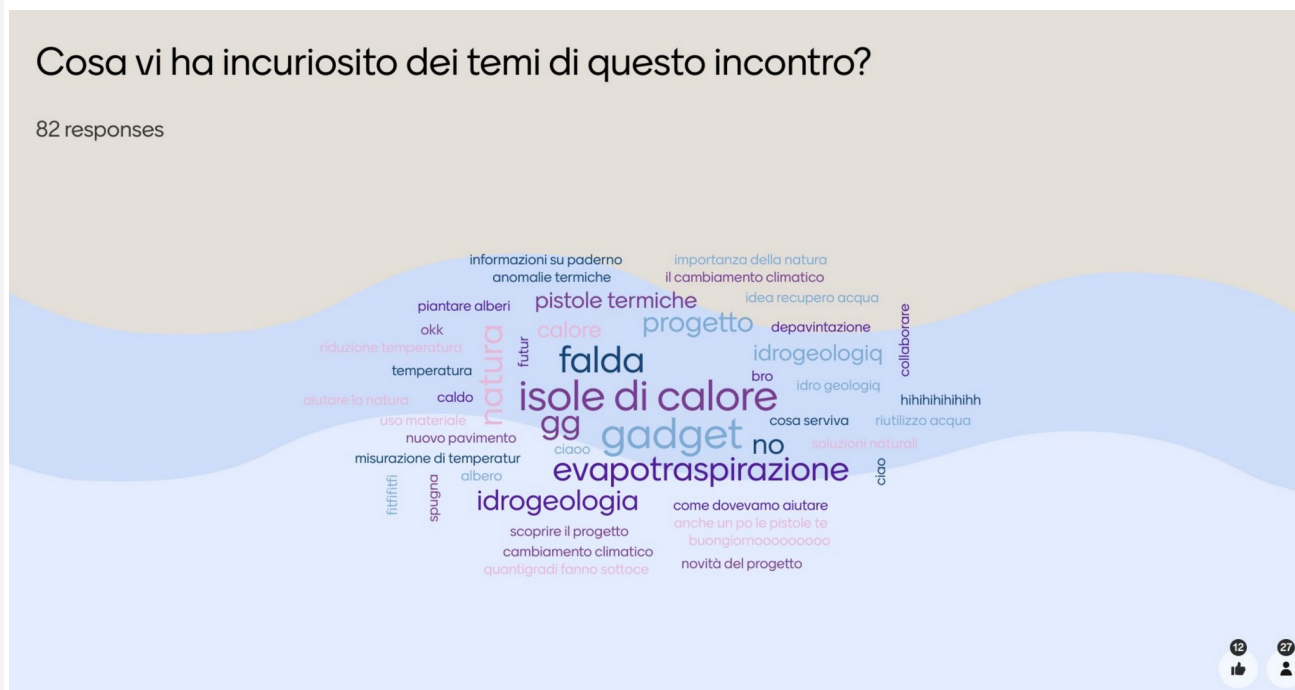


Main Interests around the Meeting

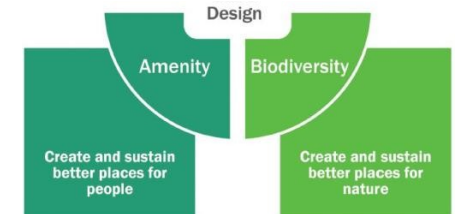
- Operation of the Parking Lot on Via Serra
- Meaning of NBS and AWR

The Public Administration's Approach in Case of Flooding/Inundation

- Key/Potential Negative Effects of Choosing NBS Instead of Traditional Interventions
- What NBS Means



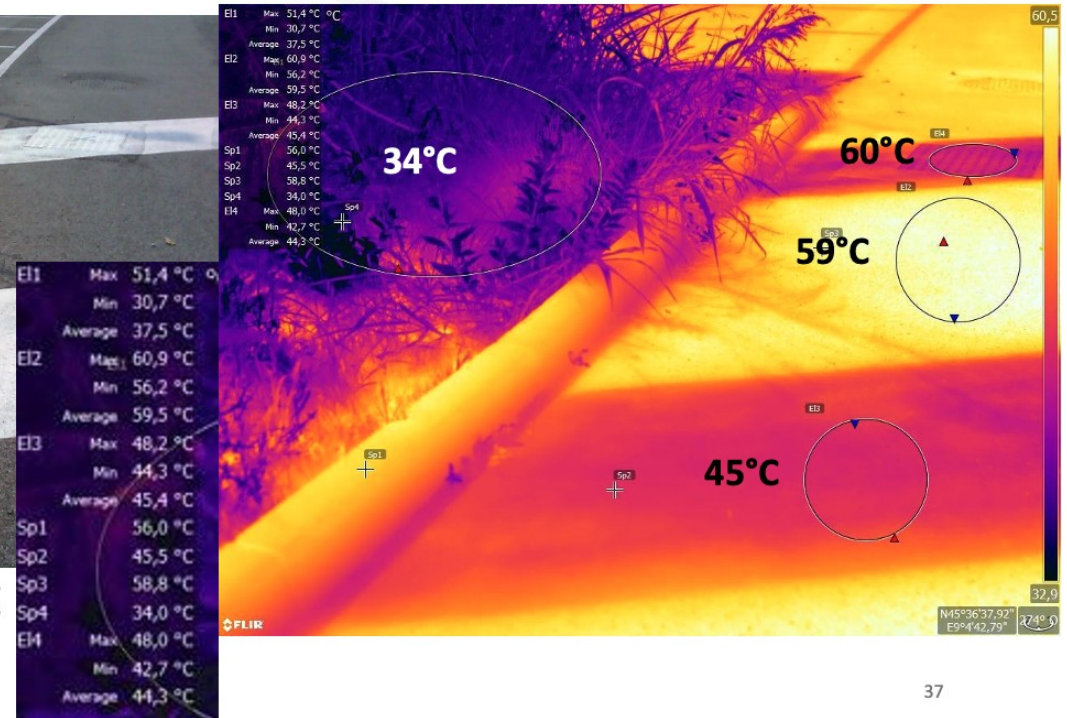
Amenity and biodiversity: Citizen Science



Last 1° August
CMM and CAP
started to set
the CS activities
on the 2 Pilots,
in particular on
heat
monitoring,
thanks to a
thermal camera



Photo credits: Prof. Eugenio Morello, Politecnico di Milano



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Amenity and biodiversity: Local Water Fora

Preliminary survey for Citizen Science activities

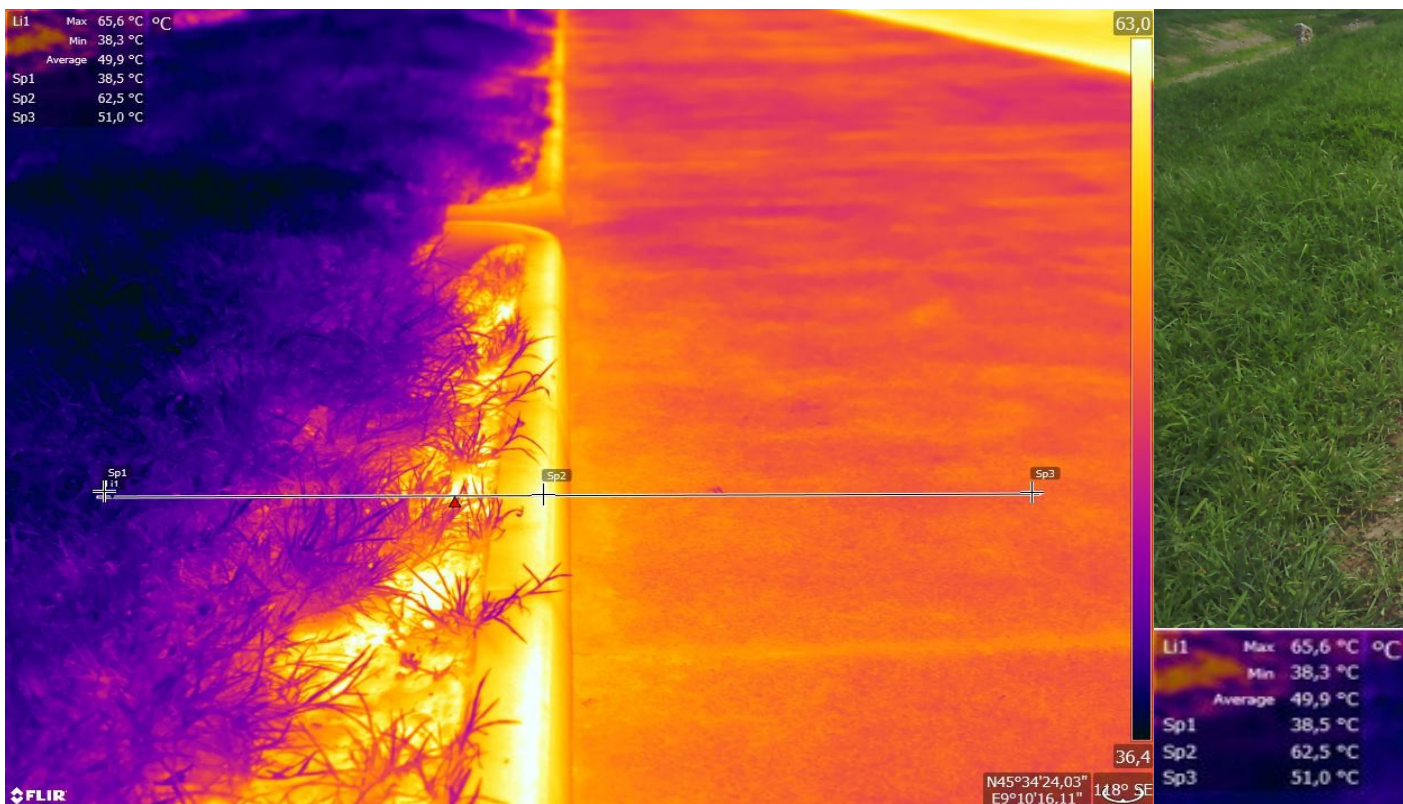
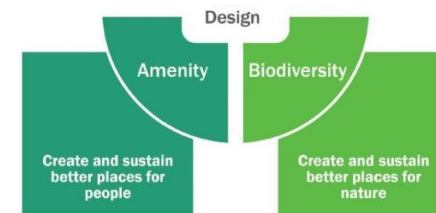


Photo credits: Prof. Eugenio Morello, Politecnico di Milano

Municipality of Paderno Dugnano

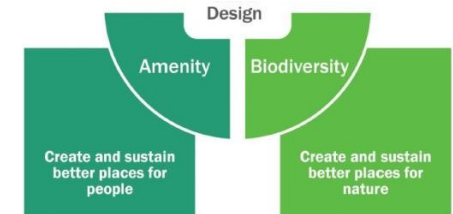
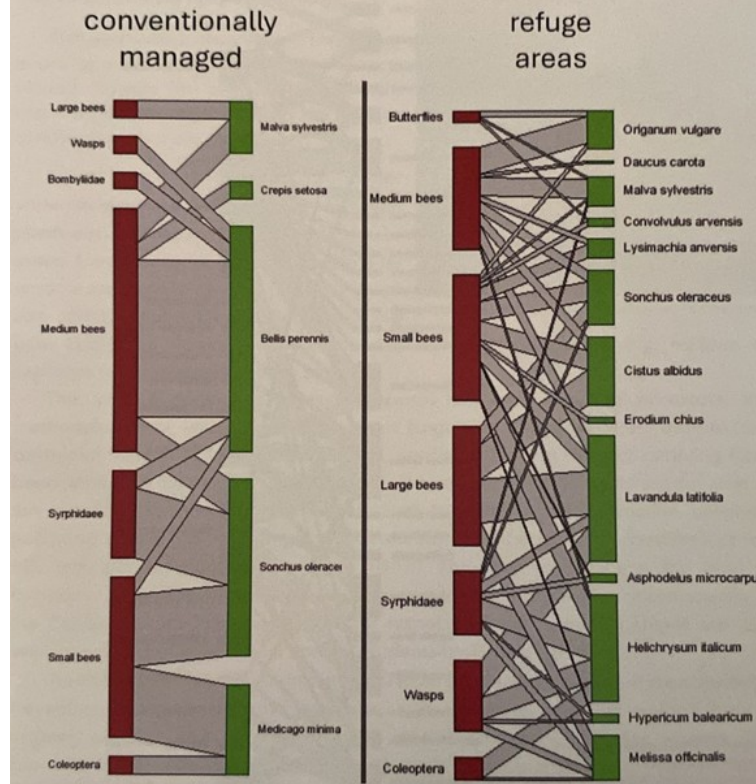
Amenity and biodiversity: Citizen Science

2) Citizen science initiatives can contribute significantly to biodiversity data.

2a) By following standardized protocols accessible to non-experts, citizen scientists can collect quantitative data that may help assess the effectiveness of pollinator protection measures (Figure 11). This 'democratization' of data collection not only increases the dataset but also fosters community engagement and awareness.

Biodiversity monitoring activity is under conceptualization:

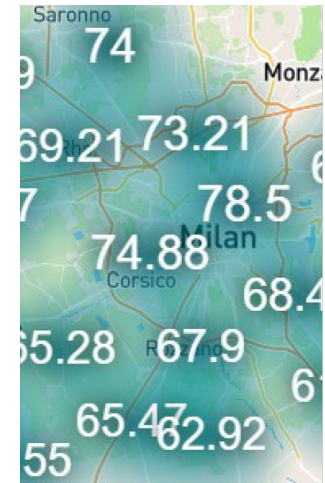
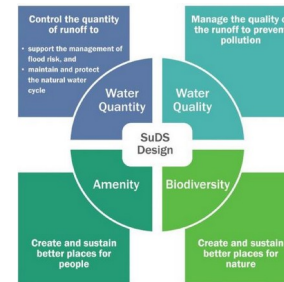
- Involve schools and young sport organisation
- Focus on insects
- iNaturalist app
- Compare monitored list of species with a theoretical list of «expected» species



CMM sponge city overall impact

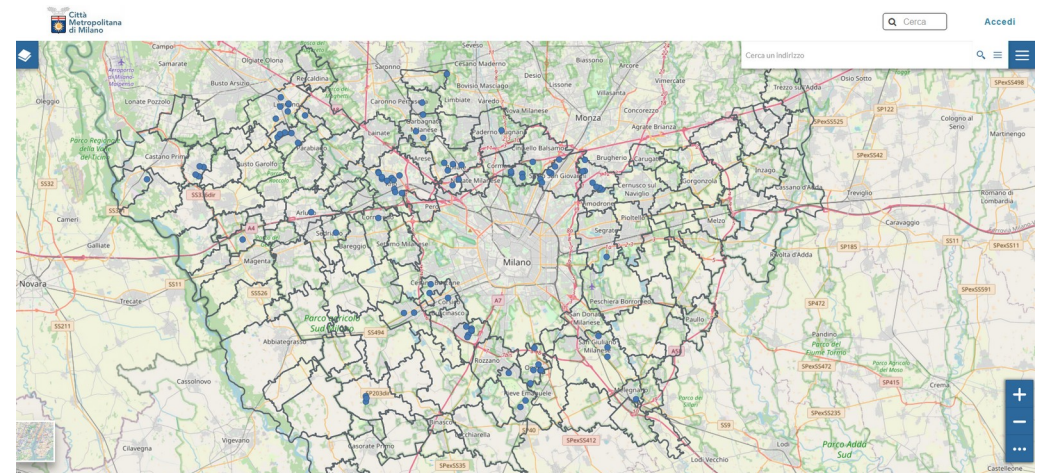
Planned

- Simplified water balance by **CMM** (additional hydrogeologist expert added to the team) – can the CMM Sponge City be considered a provider of AWR for phreatic aquifer used for not potable uses (e.g. green irrigation)?
- Multiple benefit impact estimation



Next steps

- Collection of available GIS information among **CAP** and **CMM** (e.g. rain gauges, phreatic aquifer wells and hydrodynamic etc.)
- Revision of CMM Sponge City design by **IRIDRA** (e.g. hydraulic conductivities, groundwater table, SuDS schemes)



CMM sponge city overall impact

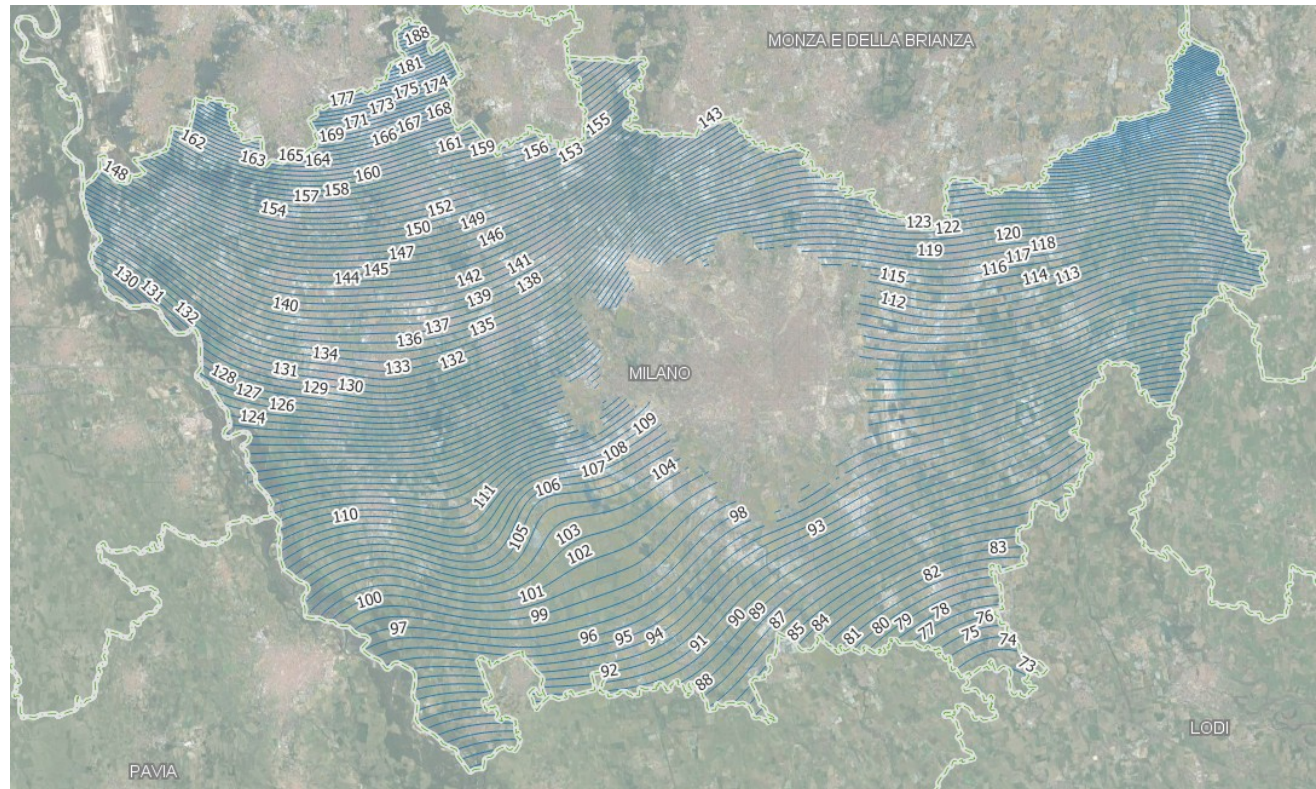
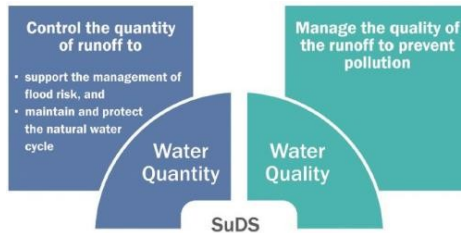
Manage the quality of the runoff to prevent pollution

Water Quality

DS

GIS map

- Aquifer depth (isopieze)



CMM sponge city overall impact

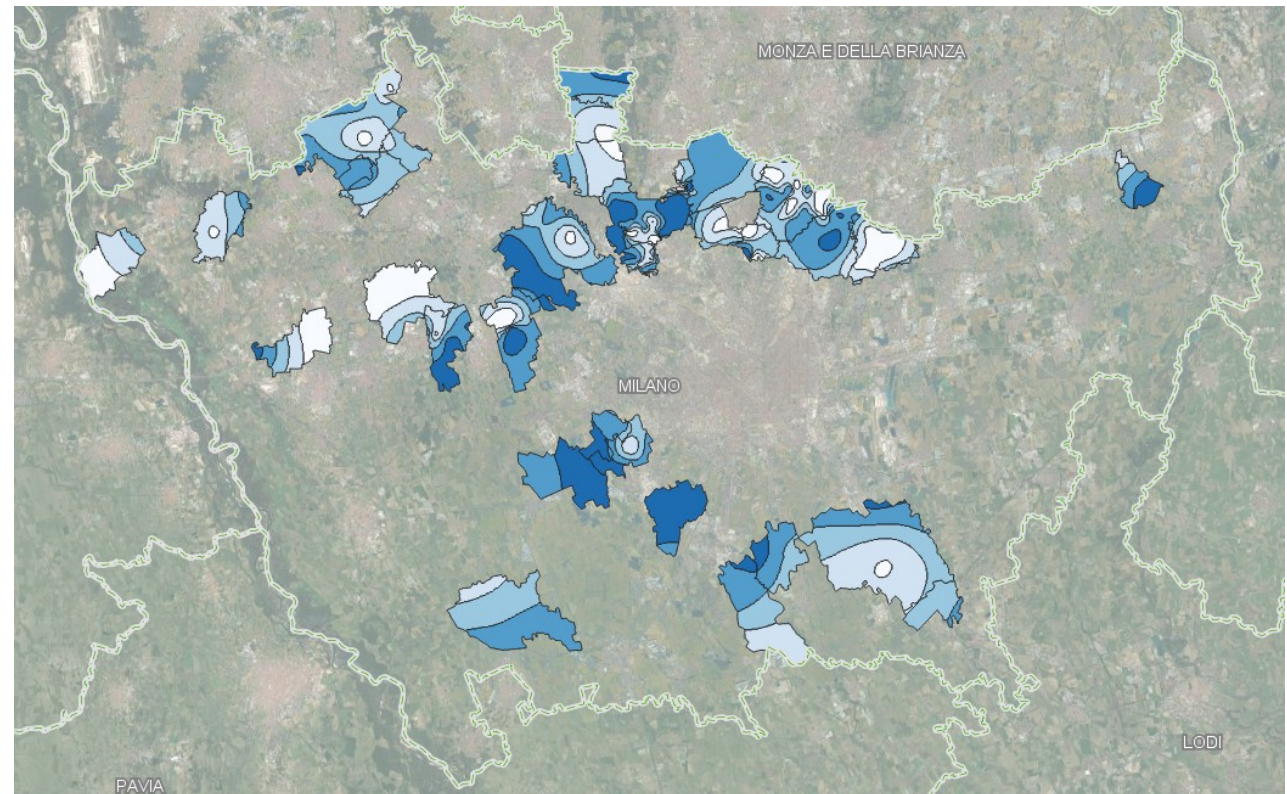
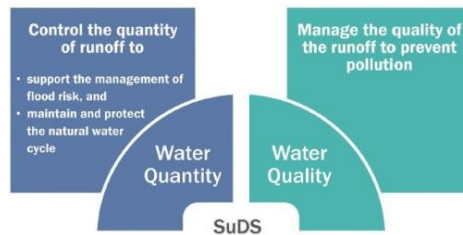
Manage the quality of the runoff to prevent pollution

Water Quality

DS

GIS map

- Hydraulic conductivities classes in the towns with SuDS interventions



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CMM sponge city overall impact

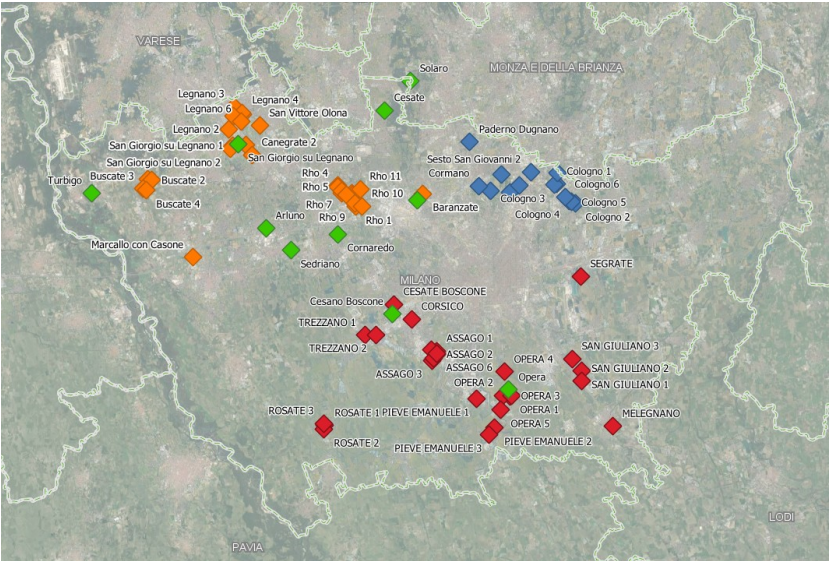
Manage the quality of
the runoff to prevent
pollution

Water
Quality

JS

GIS map

- CMM sponge city interventions
- Revision of detailed design (3 out of 4 lots)
 - Location
 - SuDS treatment train
 - Infiltration (yes/no)
 - Hydraulic conductivity (based on local geological survey)
 - Water table depth of the phreatic aquifer
 - Catchment area and type



LOT	CODICE COMMES	TERVEN	COMUNE	nome GIS	INDIRIZZO	SUDS TREATMENT TRAIN PROGETTO				INFILTRAZIONE	K _s [m/s]		PRIMA FALDA [m dal p.c.]
						1	2	3	4		3m	5m	
2 9743_05	15	Assago	Assago 5	via 1 Maggio	pavimentazione permeabile					si	2.27E-04	3.70E-04	4 s
					bacino di detenzione	trincea infiltrante				si	2.27E-04	3.70E-04	4 s
2 9743_04	16	Assago	Assago 6	via Matteotti 16-18	disoleatore	moduli geocellulari infiltranti				si	3.37E-04	6.71E-06	4 r
2 9743_51	17	Opera	Opera 1	via Bozzini	pavimentazione permeabile	trincea infiltrante				si	2.91E-07	5.91E-06	8 r
					aree di bioritenzione								
					aree di bioritenzione	trincea infiltrante							
2 9743_48	18	Opera	Opera 2	via Gramsci, Sogliani, F	bacino di detenzione	trincea infiltrante				si	9.70E-06	4.17E-07	8 r
					pavimentazione permeabile								

CMM sponge city interventions

CMM sponge city overall impact

Manage the quality of
the runoff to prevent
pollution

Water
Quality

DS

Monitoring

- Phreatic aquifer well of **CAP**

Steps completed

- Identify phreatic aquifer well close to CMM sponge city SuDS interventions
- Verification of the accessibility of the phreatic aquifer wells for water sample collection
- Development of a matrix outlining sponge city interventions and their features, along with sampling points associated with water catchments and the potential connections to the phreatic aquifer
- The possibility of using some existing piezometers for monitoring has also been investigated □ undisturbed sampling



CMM sponge city overall impact: Water quality – monitoring plan

Next steps

Monitoring plan of phreatic aquifer water quality by **CAP**

□ involvement of different departments to set up monitoring plan and feasibility

Parameters analysed:

- Chemical and physical analysis
- Metals
- Anions
- Cations
- Halogenated solvents
- Aromatic solvents
- Micro-pollutants
- Microbiology

R&D

- Coordination of CAP activities

Hydraulic invariance and sewer network

- NBS design, Geo locations, modelling of sewer network

Geological modeling

- Aquifer and wells characteristics, modelling of the aquifer

Aqueduct and WSP

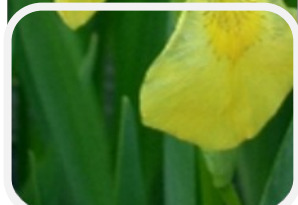
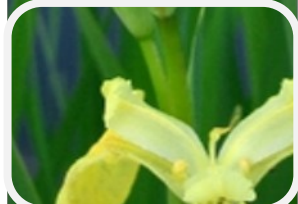
- first aquifer uses and wells locations, sampling potentialities,

Potable water lab

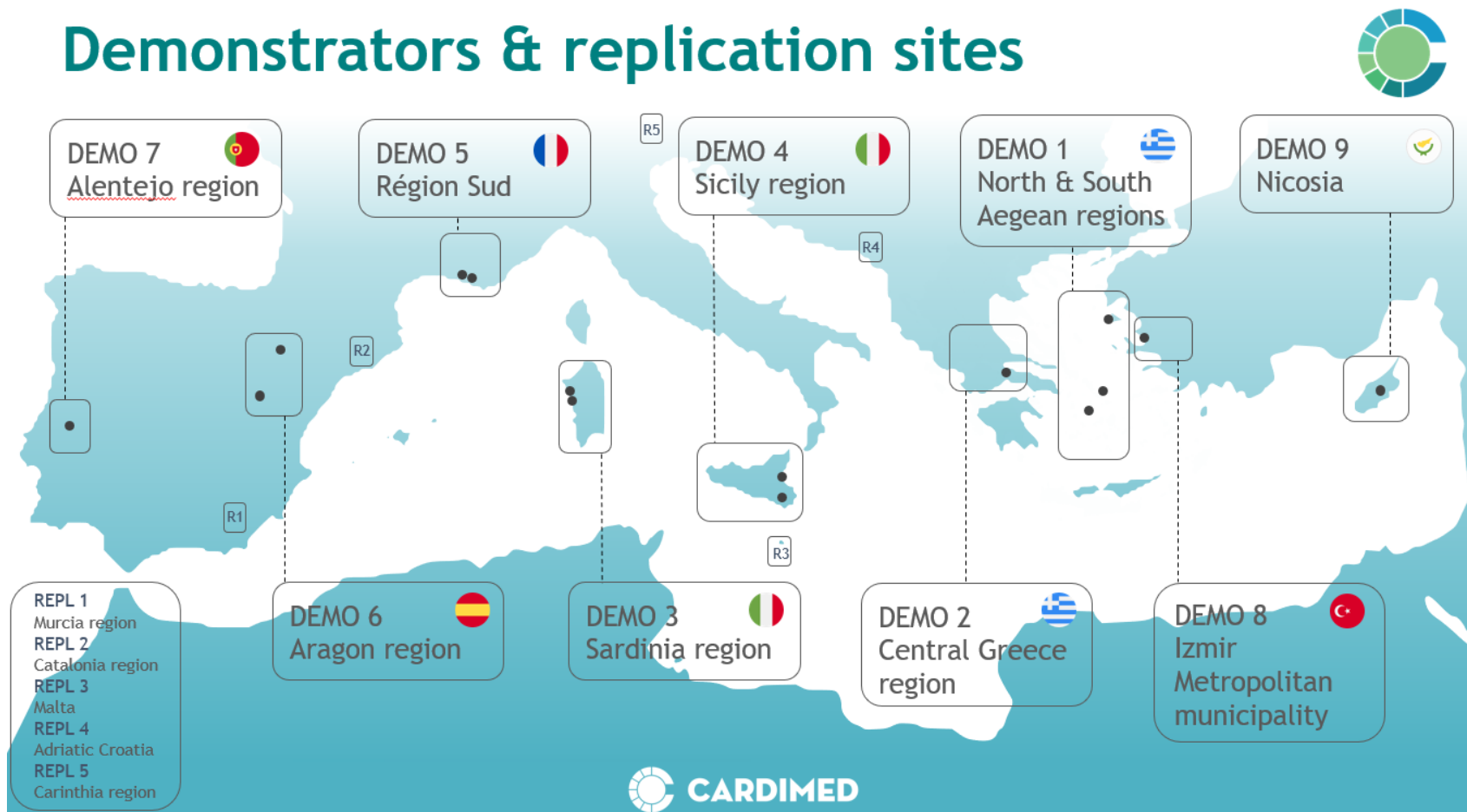
- Samples analyses

N. of sampling points	Location	Frequency	Starting date
5 wells	- Solaro - Canegrate - Trezzano S/N - San Vittore Olona - Melegnano	3 months	January 2025
2 piezometers	- Turbigo - Assago	2 months	November 2024
1 new piezometer to be verified	- Cologno Monzese	3 months	March 2025
1 well soon to be activated	- Sedriano	3 months	June 2025

Iris pseudacorus



Demonstrators & replication sites



Demo scope 4.1 – rain garden (SuDS)



- **Demo scope:**
 - Improve infiltration of stormwater
 - Contribute to flood peak reduction and delay
- **NBS addressed**
 - Bioretention cell (rain garden)



*Recent SuDS retrofitting interventions in Lombardia Region –
IRIDRA's Design and Construction supervision*



Crossroads between Andrea Doria Avenue and Via Etnea



Pluvial flooding events in Via Etnea

DEMO scheme 4.1 – rain garden



Google Earth

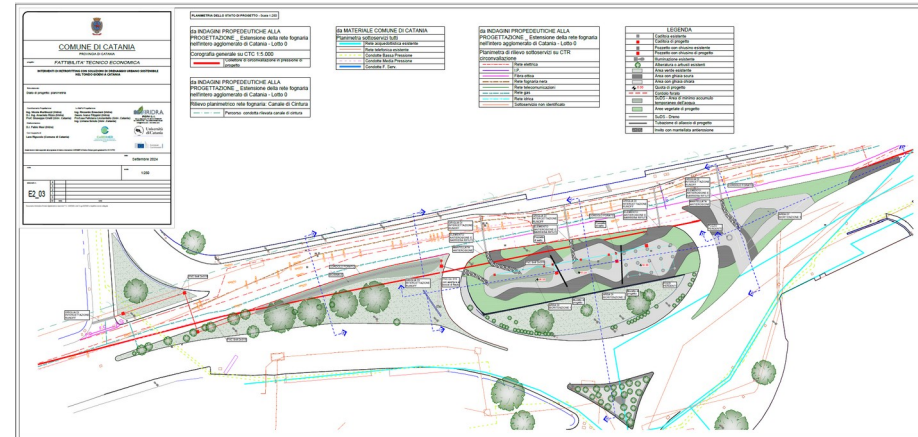


Site visit 16th November 2023

Detailed design – 4.1 rain garden



- Detailed survey and official opinions collection from local newtork utilities according to Italian law for public works (D.lgs. 36/2023) by March 2024 (M7)
- Hydrological and hydraulic modelling with HEC-RAS by UNICT, beginning April 2024 (M8)
- Basic Design based on detailed survey and hydrological and hydraulic modelling by April 2024 (M8)
- Discussion of Basic Design with MUCA and UNICT with in person meeting in May 2024 (M9)
- Discussion on possible monitoring campaign in line with mandatory KPIs and other WP4 goals (other KPIs) by IRIDRA and UNICT

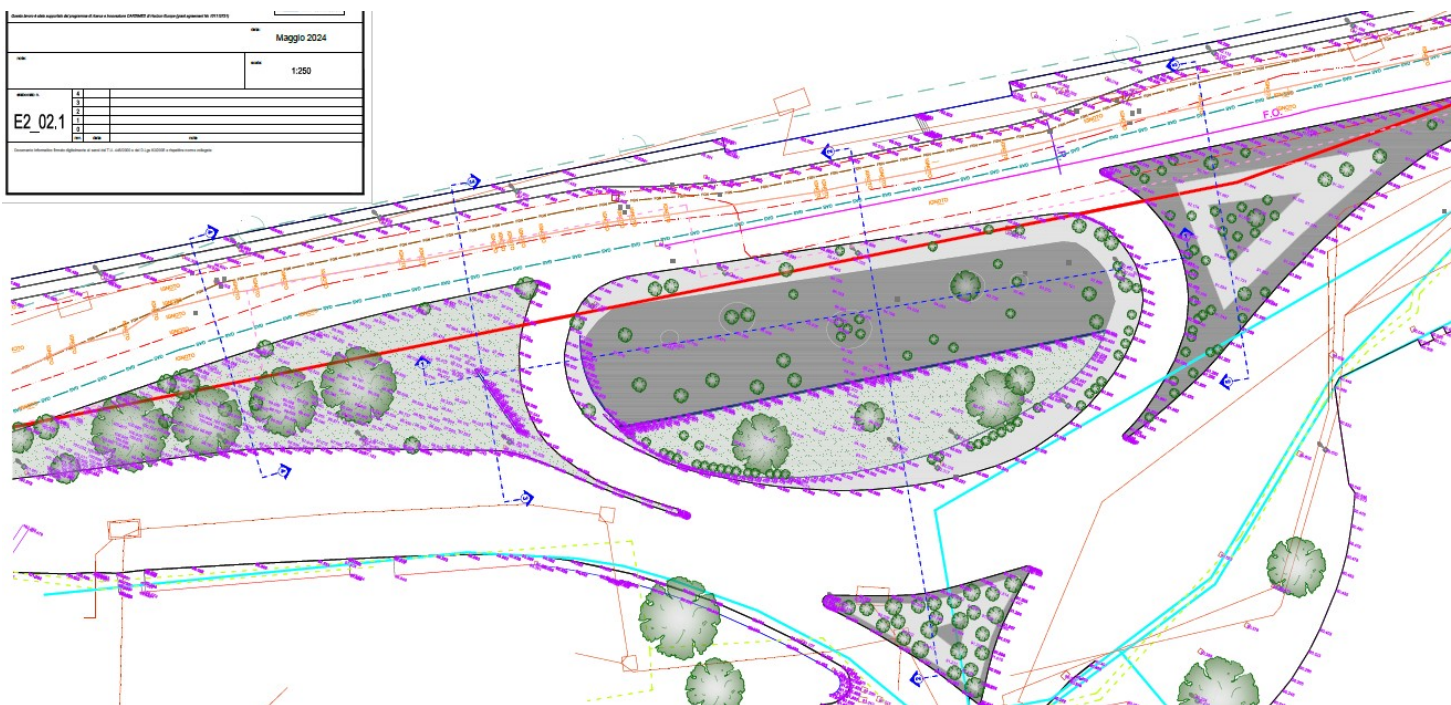


Detailed design – 4.1 rain garden



Current status

E2_02.1	
Maggio 2024	
1:250	



da INDAGINI PROPEDEUTICHE ALLA
PROGETTAZIONE _ Estensione della rete fognaria
nell'intero agglomerato di Catania - Lotto 0

Planimetra di rilievo sottoservizi su CTR
circonvallazione

—	Rete elettrica
—	I.P.
—	Fibra ottica
—	Rete fognaria nera
—	Rete telecomunicazioni
—	Rete gas
—	Rete idrica
—	Sottoservizio non identificato

da MATERIALE COMUNE DI CATANIA

Planimetra sottoservizi tutti

—	Rete acquedottistica esistente
—	Rete telefonica esistente
—	Condotte Bassa Pressione
—	Condotte Media Pressione
—	Condotte F. Serv.

da INDAGINI PROPEDEUTICHE ALLA
PROGETTAZIONE _ Estensione della rete fognaria
nell'intero agglomerato di Catania - Lotto 0

Rilievo planimetrico rete fognaria: Canale di Cintura

—	Percorso condotta rilevata canale di cintura
---	--

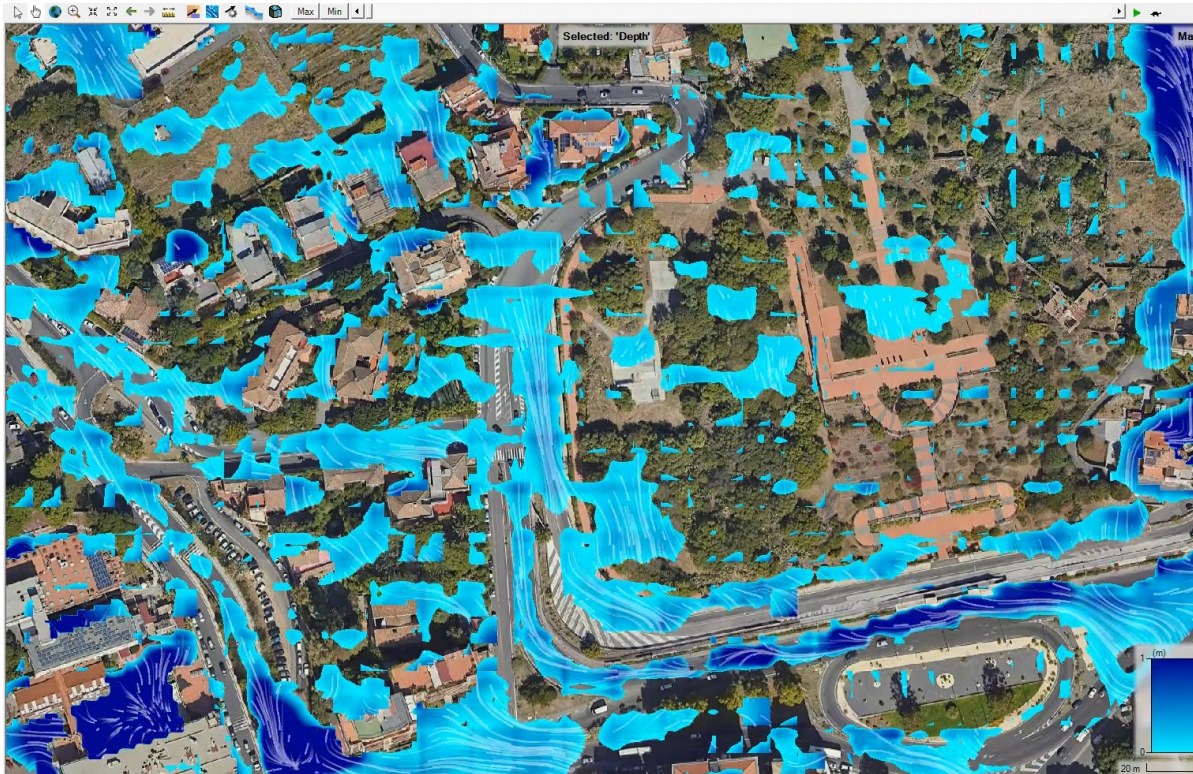


Comune di
Catania

Detailed design – 4.1 rain garden



Hydrological and Hydraulic Analyses



- Hydraulic model HEC-RAS (UniCT)
- Catechmen: 110 ha
- Peak flow in via del Bosco:
 - ✓ Tr 2 anni: 0.35 m³/s
 - ✓ Tr 50 anni: 2.51 m³/s
- Peak flow in viale Andrea Doria:
 - ✓ Tr 2 anni: 0.49 m³/s
 - ✓ Tr 50 anni: 7.52 m³/s

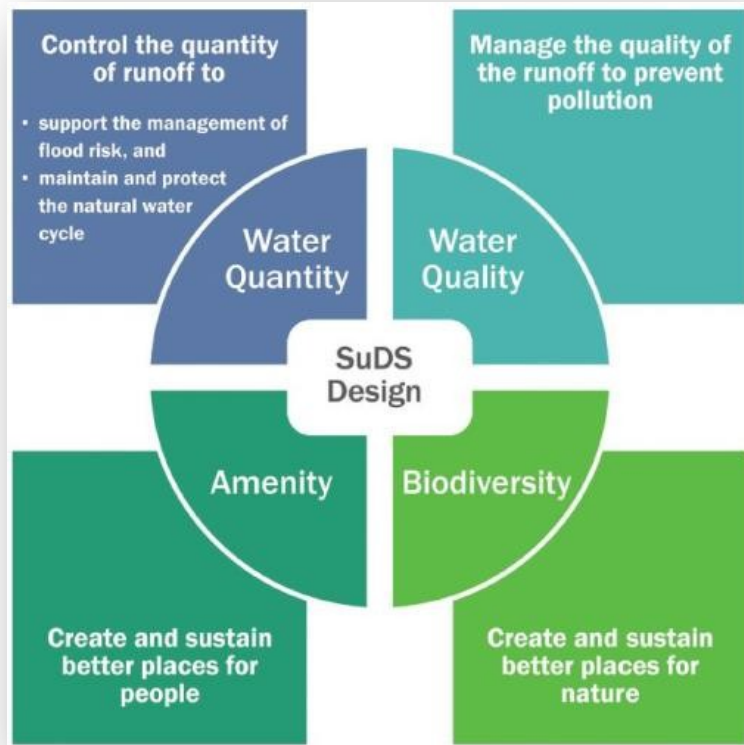


Università
di Catania

Detailed design – 4.1 rain garden



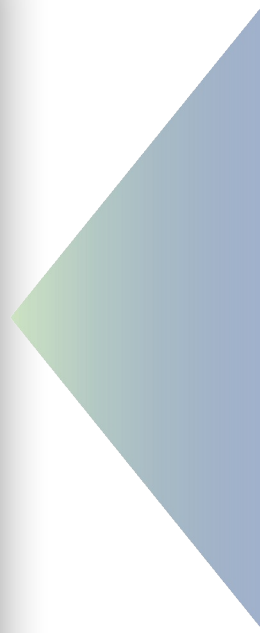
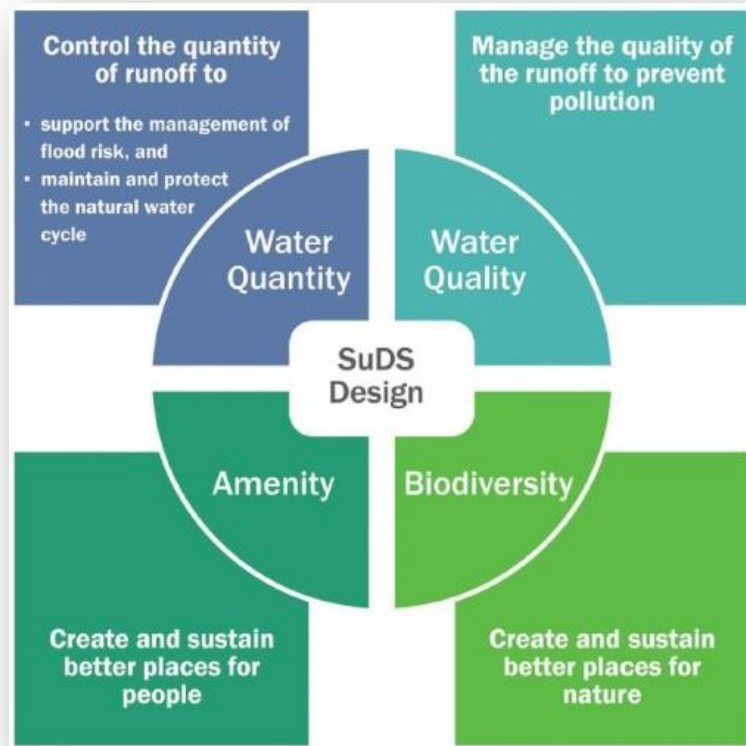
Multi-objective design



Detailed design – 4.1 rain garden



Multi-objective design



Hydraulic: **Grid + sewer** for runoff interception in via del Bosco



Griglia su strada

Aiuto verde

Strada asfaltata

Inizio bioswale

Fine bioswale

Griglia in aiuola

Area di biorientone 1

Area di biorientone 2

Pozzi perdenti

GRIGLIA Strada	PVC S8 Dn315	PVC S8 Dn315	PVC S8 Dn315	BIOSWALE 65m	PVC S8 Dn315	PVC S8 Dn315	PVC S8 Dn315	PVC S8 Dn315
1.75%	22.34%	5.76%	1.10%	0.7%	6.88%	4.55%	3.49%	3.63%

Detailed design – 4.1 rain garden

Hydraulic: Grid + sewer for runoff interception in via del Bosco

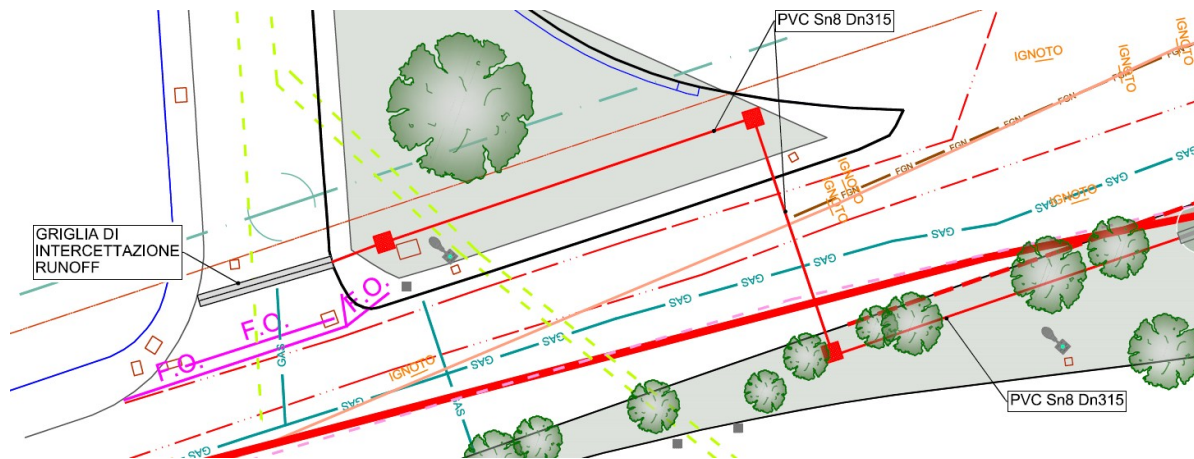


Control the quantity
of runoff to

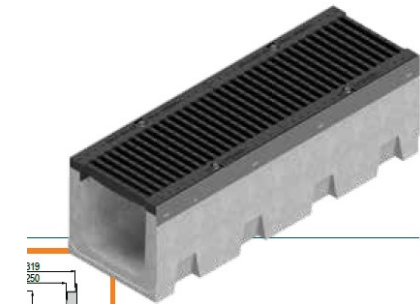
- support the management of flood risk, and
- maintain and protect the natural water cycle

Water
Quantity

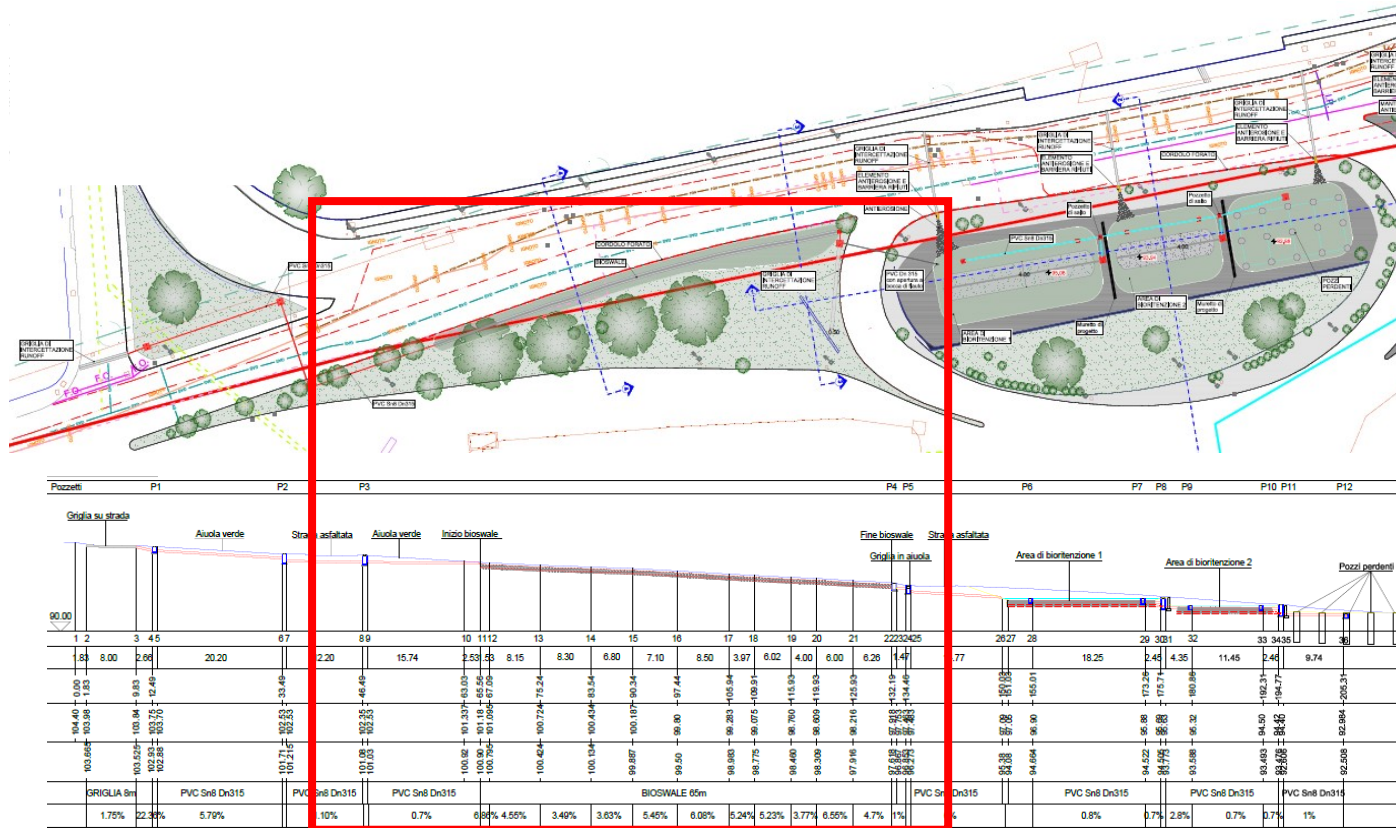
Sul



- Minimum no.2 Grid: heavy traffic load **D400**
- Target interception flow rate: **100-300 l/s**
- New separated sewer network for Adriano Doria crossing



Hydraulic: **Swale** along via Doria



Detailed design – 4.1 rain garden

Hydraulic: Swale along via Doria

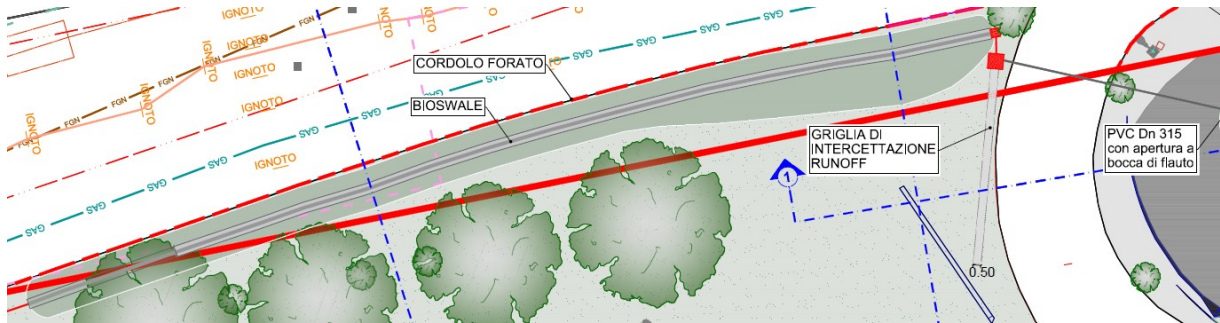


Control the quantity of runoff to

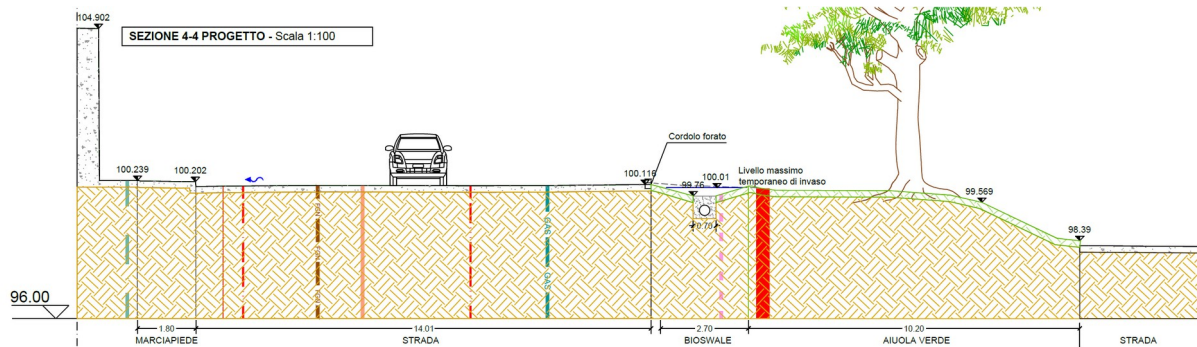
- support the management of flood risk, and
- maintain and protect the natural water cycle

Water Quantity

Sul



- Width < 3 m
- Height < 0.5 m
- Trench with gravel and underdrain
- Opened kerbs



Bioswale via Ari, Besozzo (Regione Lombardia, Italy). Design and construction supervision by IRIDRA – under construction

Idraulica: Bioretention cell/Rain garden + Infiltration Shafts



Detailed design - 4.1 rain garden

Hydraulic: Bioretention cell/Rain garden + Infiltration shafts

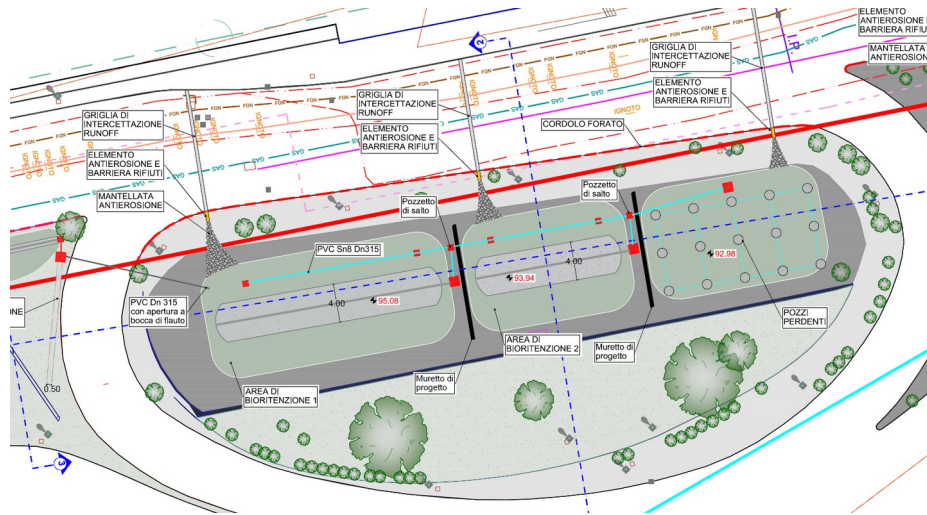


Control the quantity of runoff to

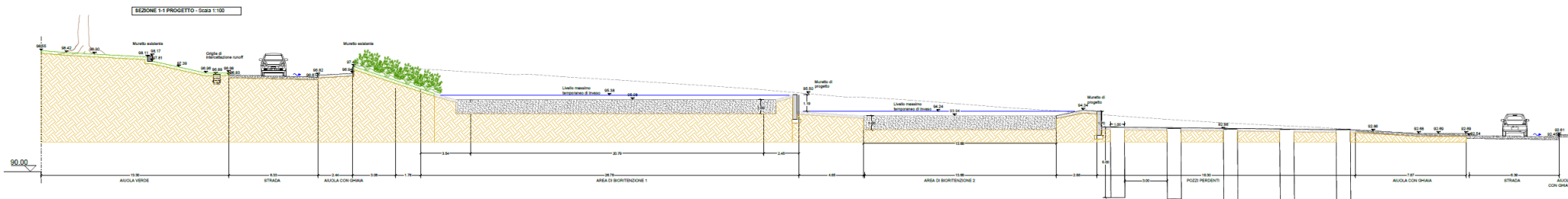
- support the management of flood risk, and
- maintain and protect the natural water cycle

Water Quantity

Su



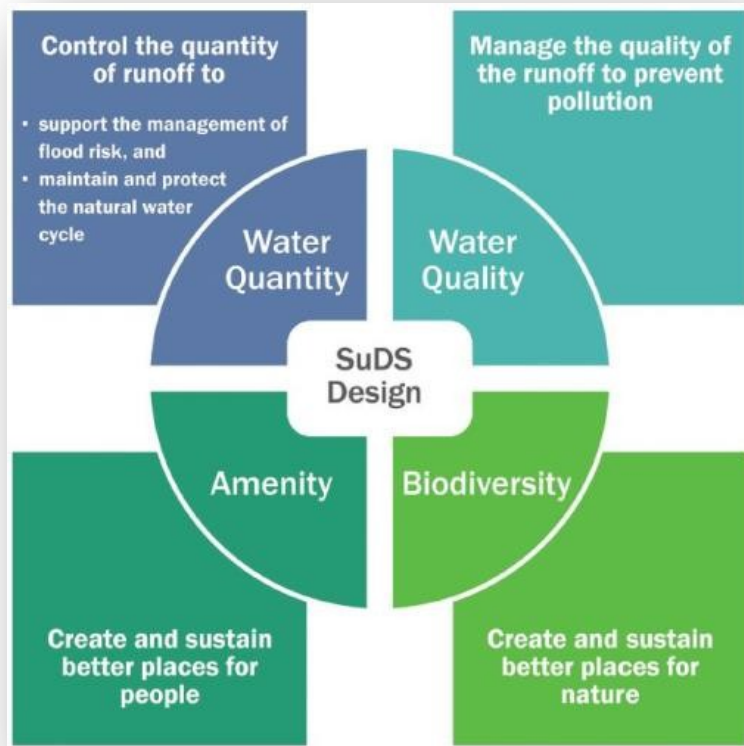
- Total area: **1500 m²**
- n° 2 bioretention cell (total area about **500 m²**)
- Maximum surface detention depth **30 cm**
- Retention volume **85 m³**
- Infiltration area e throttled effluent
- n° **15** infiltration shafts, infiltration area 200 m²
- Grid for road runoff interception (optional)



Detailed design – 4.1 rain garden



Water quality



Detailed design – 4.1 rain garden

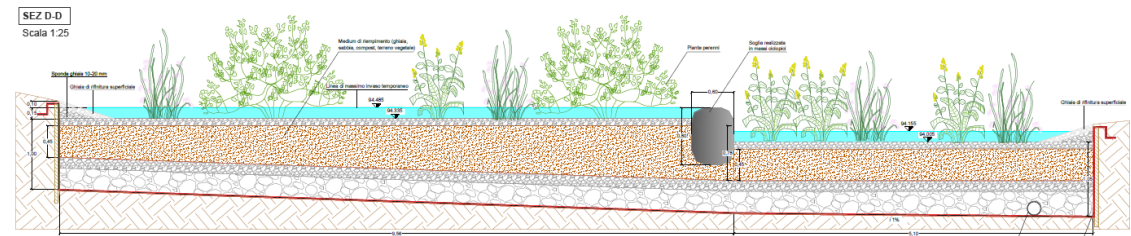
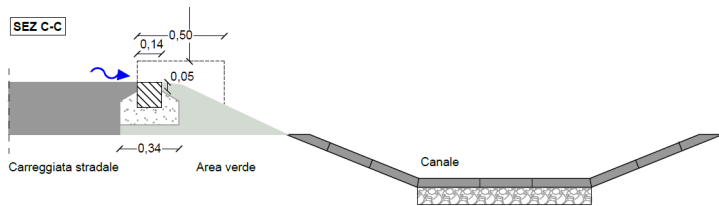
Water quality: **Swale** + Bioretention cells



Manage the quality of
the runoff to prevent
pollution

Water
Quality

DS



Swale: primary treatment

- Sedimentation
- Separation

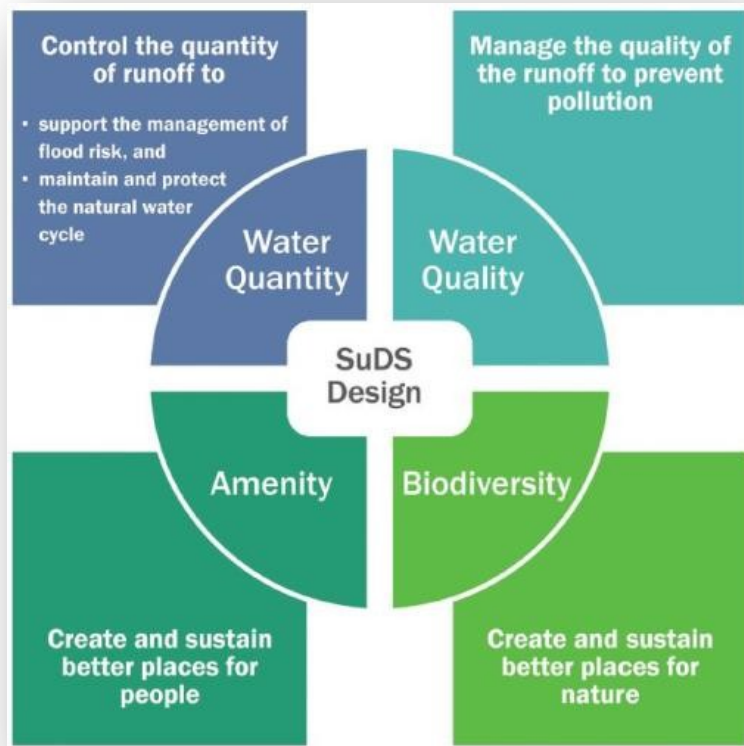
Bioretention cell: secondary treatment

- Filtration
- Adsorption
- Precipitation
- Biodegradation
- Phytoremediation

Detailed design – 4.1 rain garden



Amenity



Detailed design – 4.1 rain garden

Amenity: landscaping concept design



COMUNE DI CATANIA
PROVINCIA DI CATANIA

INTERVENTI DI RETROFITTING CON SOLUZIONI DI DRENAGGIO
URBANO SOSTENIBILE NEL TONDO GIOENI A CATANIA

CONCEPT TONDO GIOENI

COORDINAMENTO PROGETTAZIONE:

Ing. Nicola Martinuzzi (Iridra)
D.r. Ing. Anacleto Rizzo (Iridra)
Prof. Giuseppe Cirelli (Univ. Catania)

DIRETTORE TECNICO:
D.r. Fabio Masi (Iridra)

LO STAFF DI PROGETTAZIONE:

Ing. Riccardo Bresciani (Iridra)
Geom. Ivano Filippini (Iridra)
Prof.ssa Feliciano Licciardello (Univ. Catania)
Ing. Liviana Sciuto (Univ. Catania)
Paes. Michela Galletti (Iridra)



Università
di Catania



Questo lavoro è stato supportato dal programma di ricerca e innovazione CARDIMED di Horizon Europe (grant agreement No 101112731)



CATANIA CITTÀ DI FUOCO E ACQUA

Detailed design – 4.1 rain garden

Amenity: landscaping concept design



Landscape elements



Landscape view



Water: superficial and underground connections

Detailed design – 4.1 rain garden

Amenity: landscaping concept design



Amenity

Create and sustain
better places for
people

Concept 1: Porta etnea

Analizzando il contesto e la storia del luogo, emerge che Tondo Gioeni è un luogo da valorizzare in quanto punto di accesso alla città e alla via Etna.

Si trova ai piedi del parco Gioeni da dove si ha una vista panoramica della città dell'intera area di accesso a via Etna.

Il concept è quello di creare uno spazio identitario che identifichi visibilmente l'accesso alla città, riprendendone il nome e la storia e andando a creare un ambiente che richiami quello del vulcano.

Le aiuole di bionterazione, prenderanno ispirazione dal cratere del vulcano, unendo allo stesso tempo la pietra lavica e l'acqua sia come elemento caratterizzante del luogo che come elemento che appare e scompare nel progetto. A questi si può creare un effetto di vaporizzazione che richiama l'effetto del vulcano.

Allineata con il centro della via può essere inserita una o più sculture che creino un punto focale che dia allo spazio la funzione di porta, ingresso, che conduca all'interno della storia di una città di acqua e fuoco.



Ex Art Playground Öndrupsgård Ólafur elíasson



Ex Bird eye walk - taller fountain - peter walker



Concept 1: Etnea Door

Concept 2: incontro di acqua e fuoco

Il concept si ispira agli elementi caratterizzanti della città: acqua e fuoco.

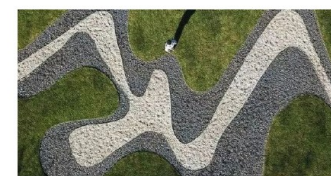
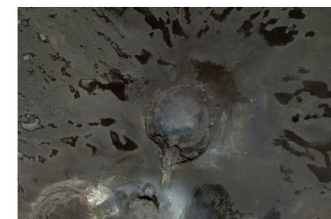
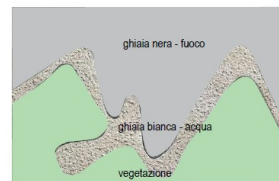
L'acqua come elemento di criticità, si trasforma in elemento di interesse, attualmente invisibile come al di sotto della città, emerge in alcuni punti in modo scenico e lasciando traccia dell'uso che se ne faceva in passato, nelle architetture storiche come terme, l'acquedotto e l'anfiteatro, in modo velato e affascinante.

Il progetto ha come obiettivo il miglioramento della gestione delle acque che risendono dal monte del parco Gioeni, attraverso la soluzione sostenibile di aree di bionterazione, questa soluzione include l'elemento acqua nel progetto, rendendolo visibile e unendolo all'altro elemento che caratterizza la città, il fuoco, ovvero la pietra lavica che viene utilizzata come elemento decorativo del progetto.

I raingarden sono l'acqua e i due sistemi nella loro temporaneità si incontrano nella piazza. A questi 2 sistemi si aggiunge il 3 che è quello della vegetazione.

La pattern dei 3 sistemi, riprende la forma della lava, il suo disegno che in modo plastico si estende sulle superfici che incontro, come parte del territorio, alle fondamenta della città e presente e ripetuta all'interno di essa con i suoi contrasti di colore, e il suo costante richiamo al vulcano.

All'interno di questo scenario la vegetazione si sviluppa soprattutto nella fascia verde, creando un bordo compatto, ma anche nelle aree a ghiaia dove però sono selezionate specie pioniere che non sono presenti in tutti i mesi dell'anno, lasciando la ghiaia come elemento costante del progetto.



Concept 2: Water and fire

Detailed design – 4.1 rain garden

Amenity: landscaping concept design

Concept 1: Porta etnea

Analizzando il contesto e la storia del luogo, emerge che l'accesso alla città e alla via Etna.

cesso alla città e

Si trova ai piedi del parco Gioeni da dove si ha una vista panoramica della città dell'intera area di accesso a via Etna.

Il concept è quello di creare uno spazio identitario che identifichi visibilmente l'accesso alla città, riprendendone il nome e la storia e andando a creare un ambiente che richiami quello del vulcano.

Le aiuole di bionterrenze, prenderanno ispirazione dal cratere del vulcano, unendo allo stesso tempo la pietra lavica e l'acqua sia come elemento caratterizzante del luogo che come elemento che appare e scompare nel progetto. A questi si può creare un effetto di vaporizzazione che richiama l'effetto del vulcano.

Allineata con il centro della via può essere inserita una o più sculture che creino un punto focale che dia allo spazio la funzione di porta, ingresso, che conduca all'interno della storia di una città di acqua e fuoco.



Ex. Art Playground Öndrupsgård Olafur eliasson



Ex. Bird eye walk - tanner fountain - peter walker



Concept 1: Etna Door

Concept 2: incontro di acqua e fuoco

Il concept si ispira agli elementi caratterizzanti della città: acqua e fuoco.

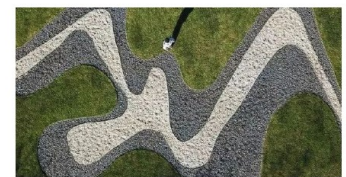
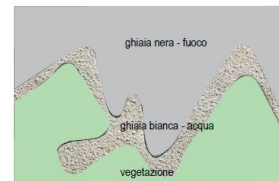
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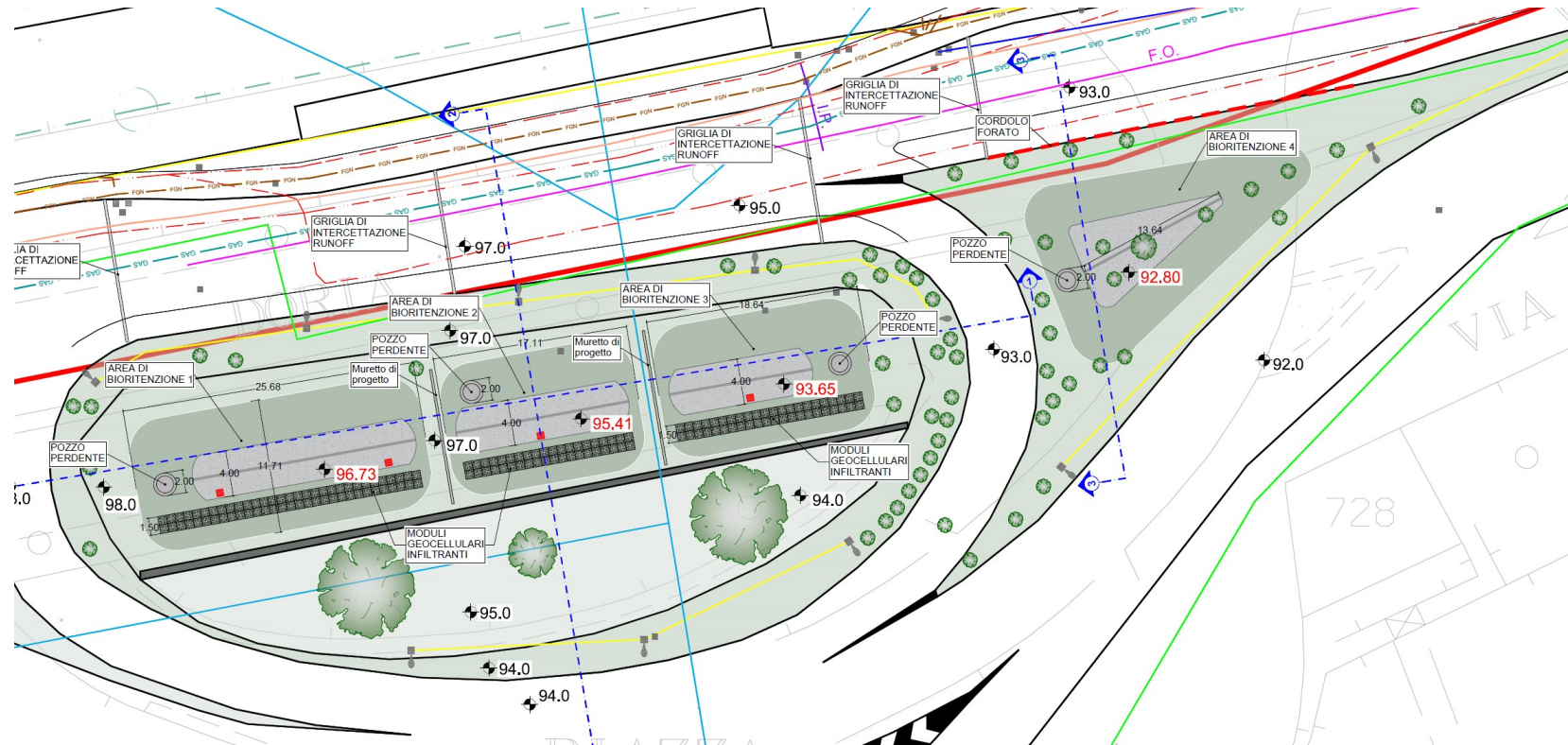
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Concept 2: Water and fire

Detailed design – 4.1 rain garden

Amenity: landscaping concept design



Detailed design – 4.1 rain garden

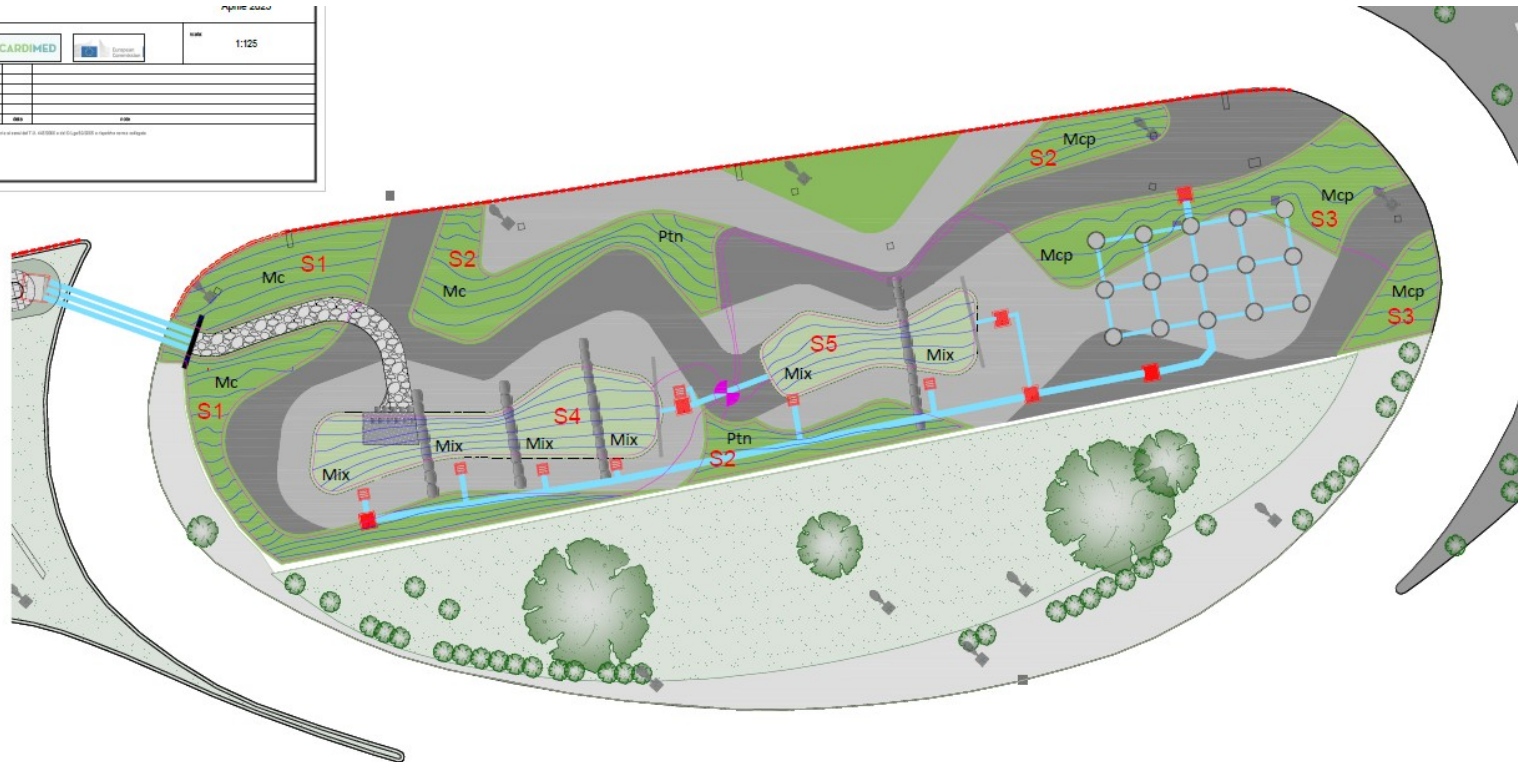
Amenity: landscaping concept design



Amenity

Create and sustain
better places for
people

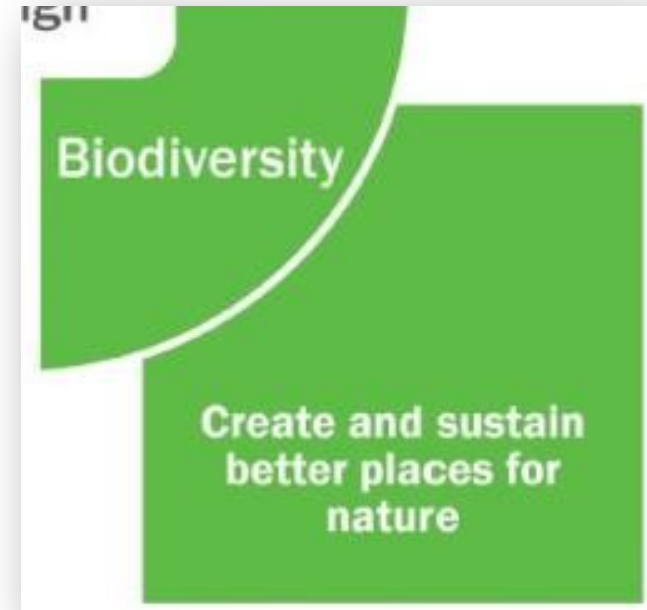
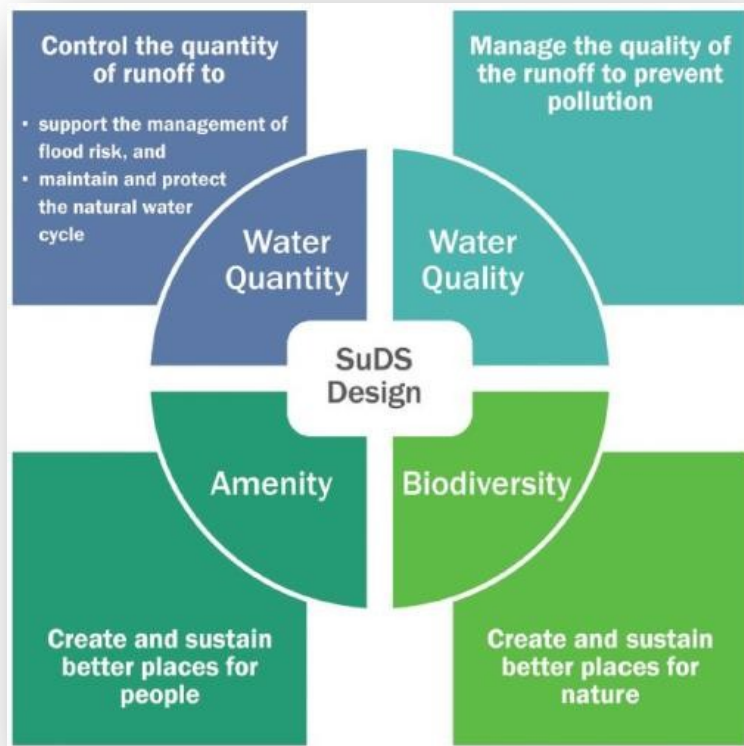
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4			
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Notes			
1. All dimensions are in millimetres (mm) unless otherwise stated.			



Detailed design – 4.1 rain garden



Idraulica



Detailed design – 4.1 rain garden

Biodiversity: planting – Concept 1



Scelta delle specie 1: Contrasti mediterranei

Nel layout selezionato si sono studiate 2 strategie diverse per la scelta della vegetazione, in entrambi i casi le specie selezionate appartengono alla flora mediterranea, con attenzione alle specie locali.

In questa prima ipotesi si sceglie di esaltare di più i contrasti lasciando le fasce a ghiaia libere dalla vegetazione e selezionando gruppi di arbusti molto compatti e sempreverdi per esaltare le linee del disegno e i contrasti di materiali.

Per avere maggiore copertura di vegetazione, nel layout possono essere inseriti piccoli alberi o arbusti a portamento arbustivo che però parzialmente andrebbero a nascondere il layout dei diversi sistemi nella vista dall'alto.

A sinistra: immagine di riferimento di un progetto di Burle Marx

Mediterranean contrast

- > Amenity
- < Biodiversity

Arbusti



Pittosporum tobira nano



Thymus capitatus



Pistacia lentiscus

Piccoli alberi



Pistacia vera



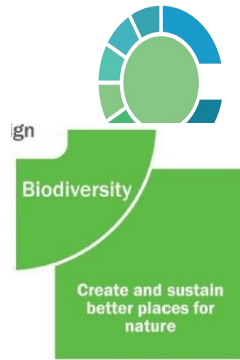
Arbutus unedo



Genista aetnensis

Detailed design – 4.1 rain garden

Biodiversity: planting – Concept 2



In alto: Immagine di un progetto di Philippe Olivier

Scelta delle specie 2: Mimesi

In questo secondo layout, si mantiene la scelta di esaltare le linee del disegno attraverso l'uso di specie vegetali e alla scelta di specie autoctone, ma in questo caso la scelta è diversa.

Il contrasto in questo caso rimane soprattutto nei colori, ma la scelta delle specie viene fatta affinché si vadano a mimetizzare le piante con il colore del materiale della ghiaia:

- per la ghiaia bianca si è scelto di utilizzare un insieme di specie con foglie argenteo-glauche che si fingeranno di colore nel breve momento della fioritura
- per la ghiaia nera, la scelta è su piante con foglie o fioritura molto scure tendente al nero.

L'ultimo sistema è quello del verde che invece sarà sempre ricco di colori e varietà rievocando le fioriture del contesto naturale locale.

Mimesi

- < Amenity
- > Biodiversity

Perenni su ghiaia nera



Aeonium



Agapanthus

Perenni su ghiaia bianca



Leucium fruticans



Cerastium tomentosum

Perenni su ghiaia nera



Aeonium



Cistus creticus incanus



Myrtus communis



Rosmarinus officinalis



Erica terminalis

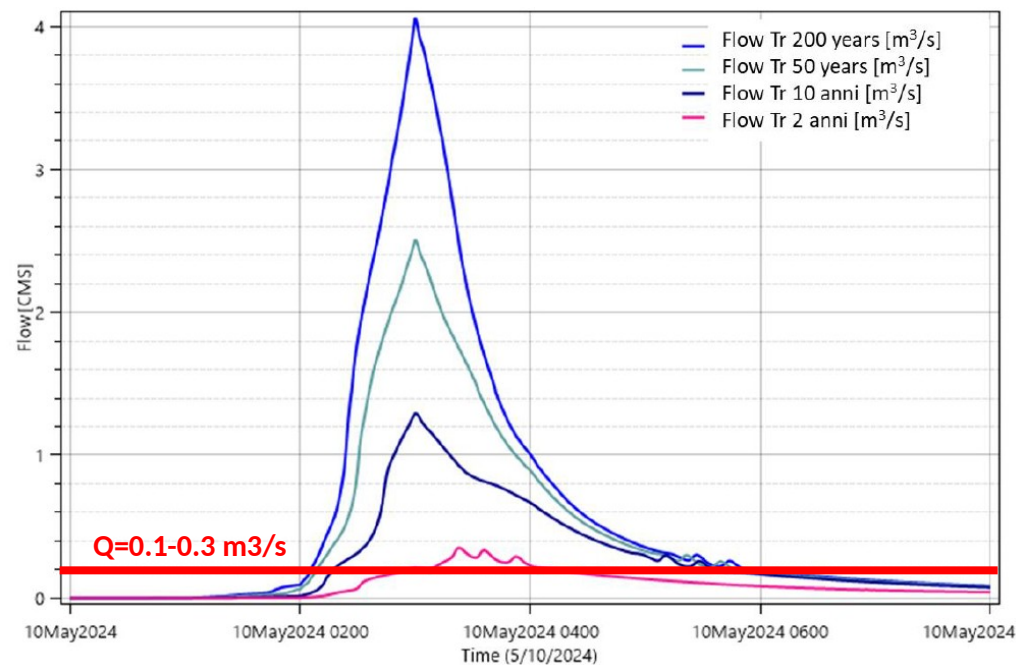
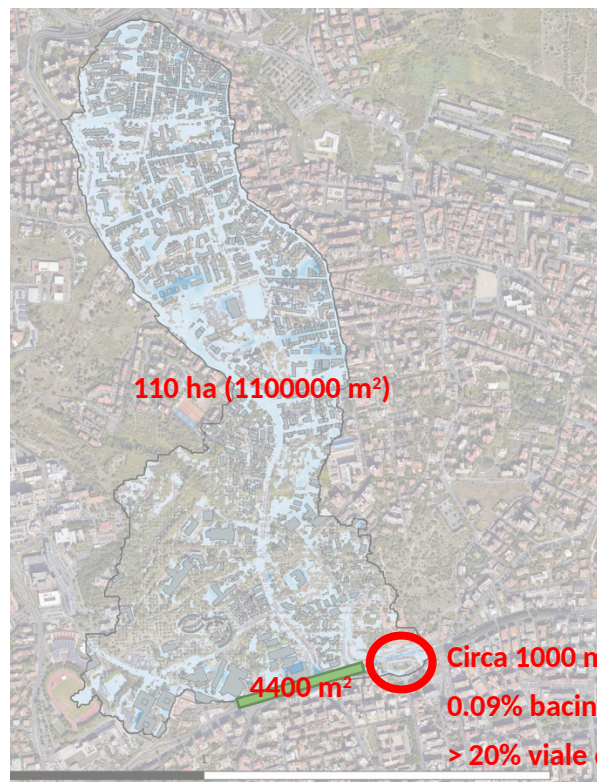




Development since the last CM in March – 4.1 rain garden



Pluvial flooding: DEMO 4 as starting point.....



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