



Operationalisation of Natural  
Capital and Ecosystem Services

# **Un caso applicativo di servizi ecosistemici: il trattamento naturale delle acque di sfioro nel progetto OPENNESS**

[www.openness-project.eu](http://www.openness-project.eu)

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OpenNESS has received funding from the European Union's  
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# EU FP7 project OpenNESS (Dec 2012 - May 2017)

## Aim:

deliver innovative and **practical ways of applying the concepts of Ecosystem Services** in land, water and urban management in Europe, and examine how these concepts are involved in key EU challenges: well-being, sustainable development, governance and competitiveness.



From concepts to real-world applications  
[www.openness-project.eu](http://www.openness-project.eu)

# 27 case studies

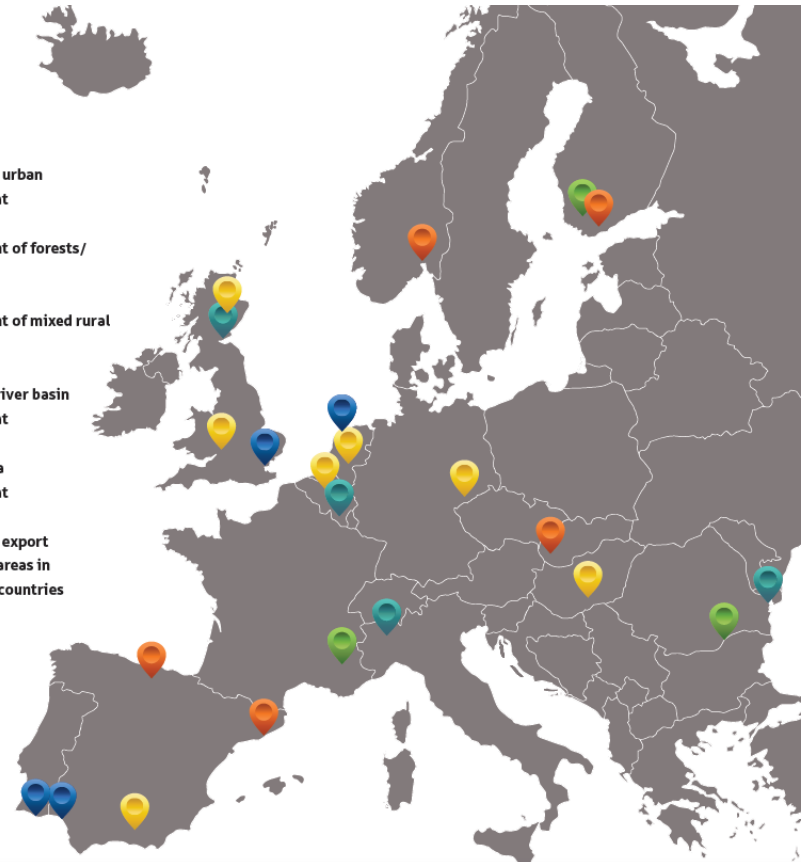
To achieve these goals, the project will apply the concepts and methods in 27 case studies. Key to the operationalisation of concepts is the involvement of local **stakeholders** and **SMEs** in the research

## Case studies

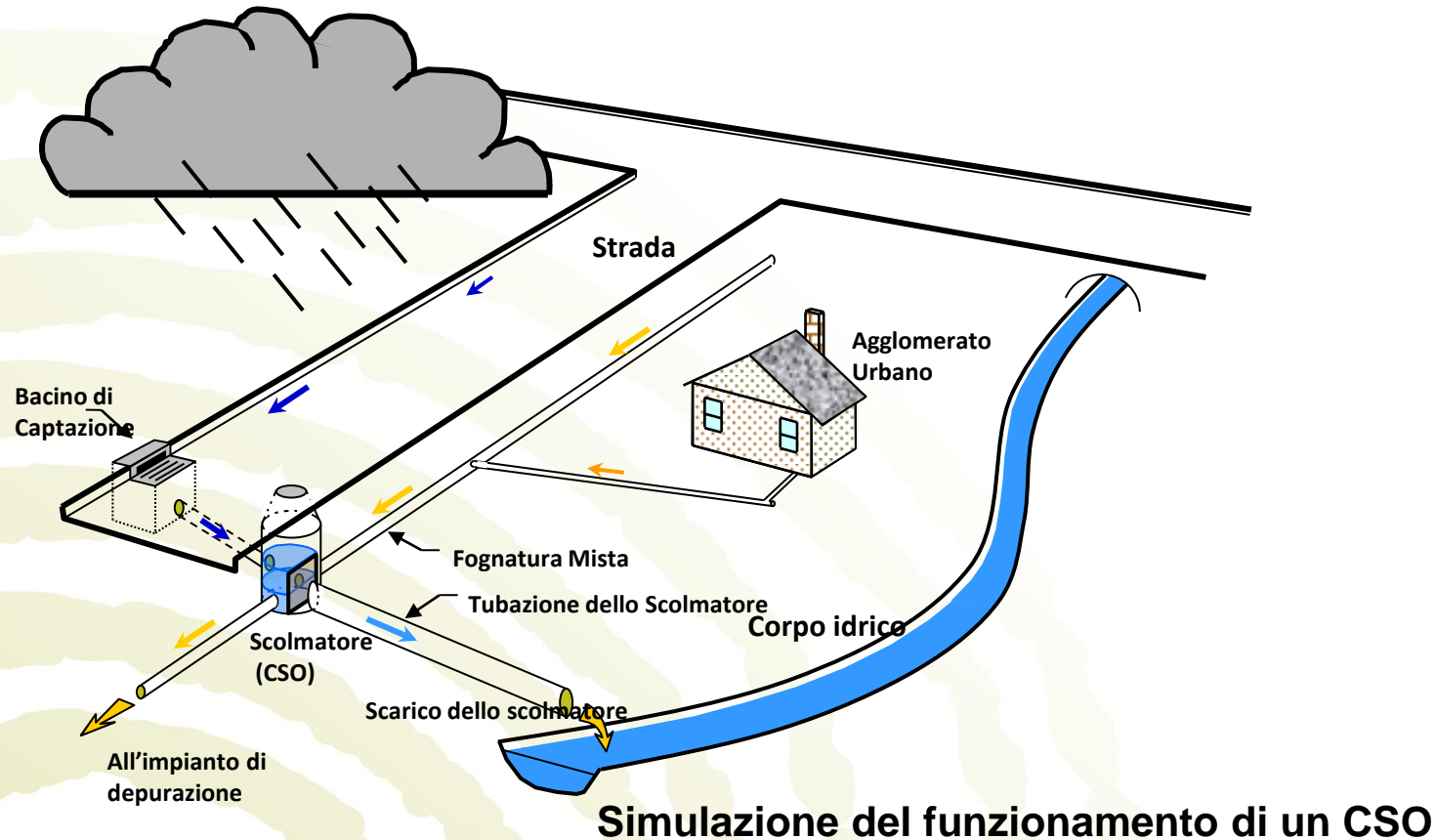
The OpenNESS case studies cover a range of socio-ecological systems and are clustered according to the policy and management focus for ecosystem service operationalisation.



-  Sustainable urban management
-  Management of forests/woodlands
-  Management of mixed rural landscapes
-  Integrated river basin management
-  Coastal area management
-  Commodity export dominated areas in developing countries



# Il problema: l'inquinamento provocato dalle reti miste



# Il problema: l'inquinamento provocato dalle reti miste

Le stime dei carichi inquinanti sulle acque in Emilia Romagna  
(T/anno BOD)

Depurat. civili	Reti non depurate	Carico ecced.	Scaricat. Reti miste	Industria	diffuso	Totale
7.600	4.500	3.070	9.250	3.830	18.300	46.800

# Soluzioni possibili

- Intervenire a monte: evitare l'afflusso di acque di pioggia in fogna:
  - Separazione reti
  - SUDS
- Intervenire a valle: trattare le acque di pioggia in eccesso
  - Vasche di prima pioggia
  - Sistemi di trattamento in situ



# The case study of Gorla (Italy)

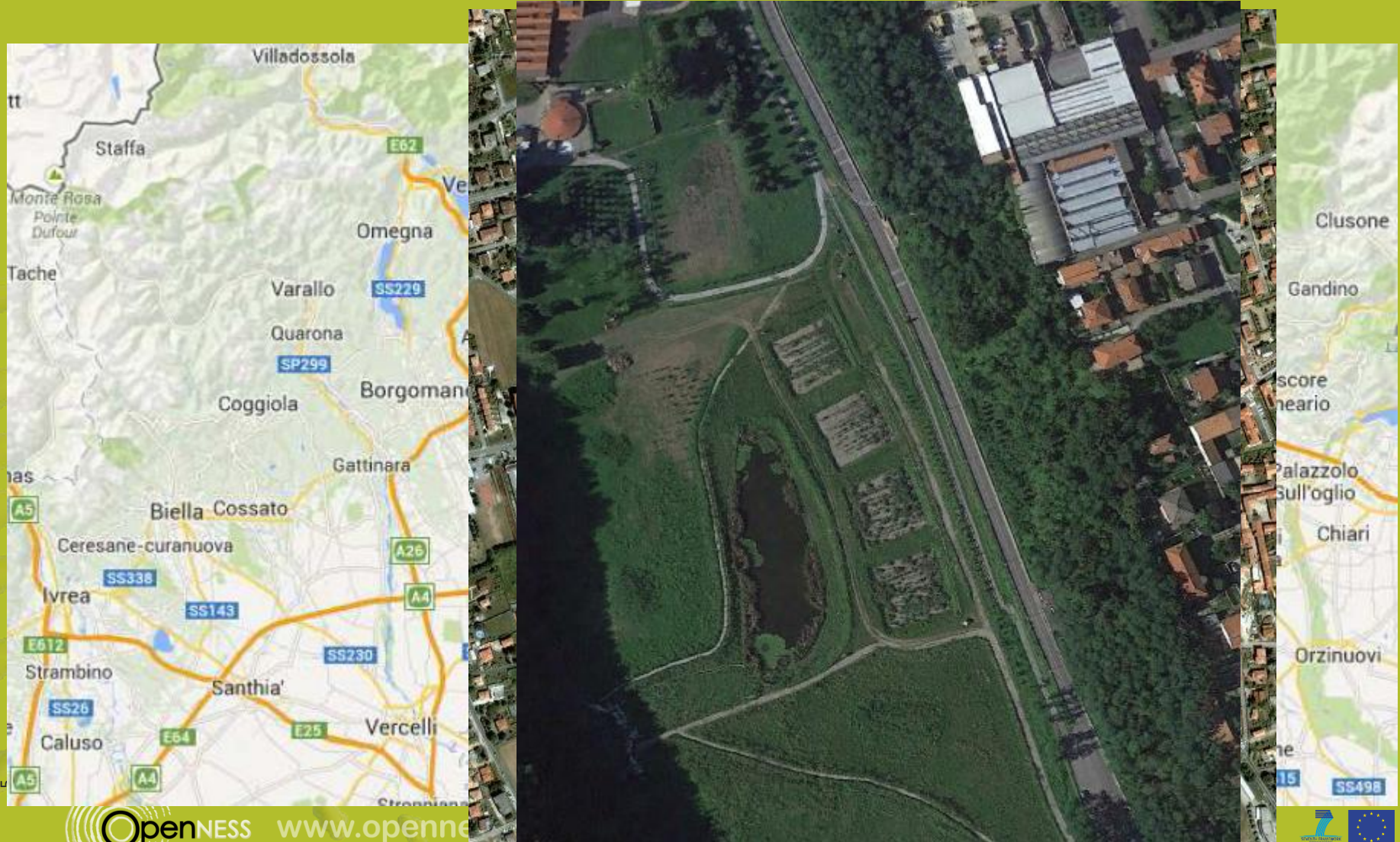
The Gorla park is a new ecosystem including a constructed wetland (green infrastructure) built on the floodplain of the Olona River in an area previously used for poplar plantation



## Key issues from ecosystem service perspective:

1. **Quantification and economic evaluation** of the different ecosystem services provided (multi-criteria analysis, willingness to pay)
2. Comparison of **green vs. grey** infrastructures generally used for combined sewer overflow (CSO) for pollution control and flood prevention (analysis of scenario and trade-offs)
3. Explore the possibility to integrate the ecosystem service approach in the **decision making process** and in river basin management plans, through the direct involvement of the stakeholders in the research

# A map of the case study area





# Ecosystem services

Provisioning services	Timber extraction
Regulation and maintenance services	Water purification
	Flood protection
	Maintaining populations and habitats (wildlife)
Cultural services	Recreation



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## ALTERNATIVE 0: POPLAR PLANTATION

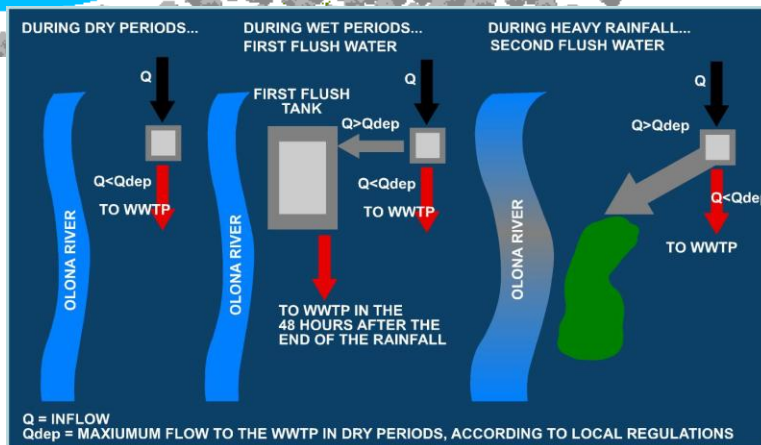
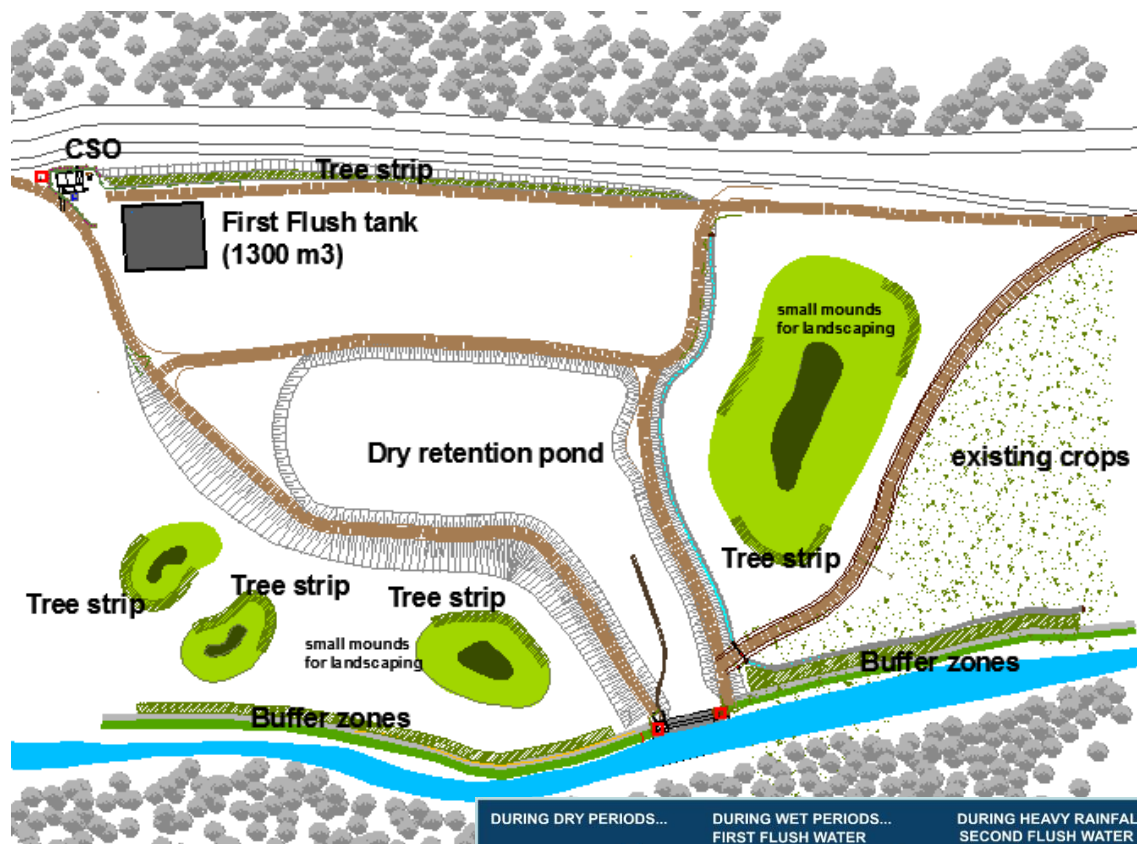


	m <sup>2</sup>
Poplar grove	36.000
Reed zones	0
Wetland zones	0
Buffer zones and trees	0

The area was originally a poplar plantation. Alternative 0, “doing nothing”, therefore envisages the use of the area for productive forestry



ALTERNATIVE 1: FIRST FLUSH STORAGE TANK AND DRY RETENTION POND FOR SECOND FLUSH VOLUME



	m <sup>2</sup>
Poplar grove	0
Reed zones	0
Wetland zones	0
Buffer zones and trees	2000

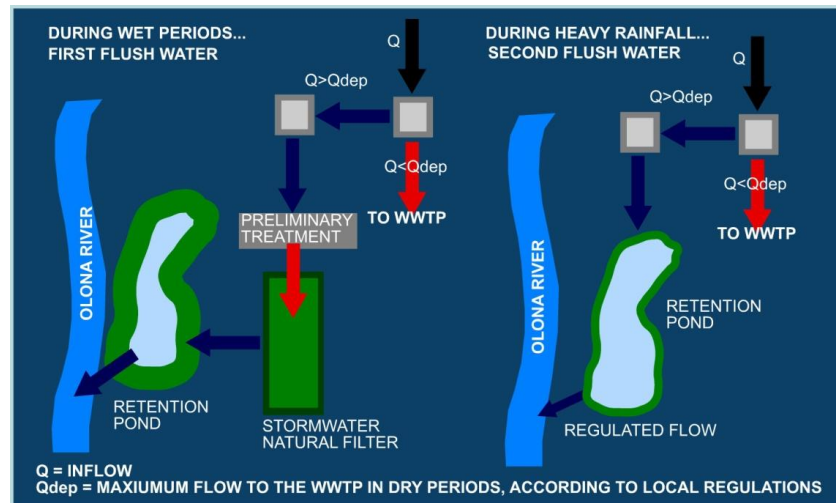




ALTERNATIVE 2: THE RIVERINE WATER PARK, CSO TREATMENT BY  
CONSTRUCTED WETLAND AND WET RETENTION POND



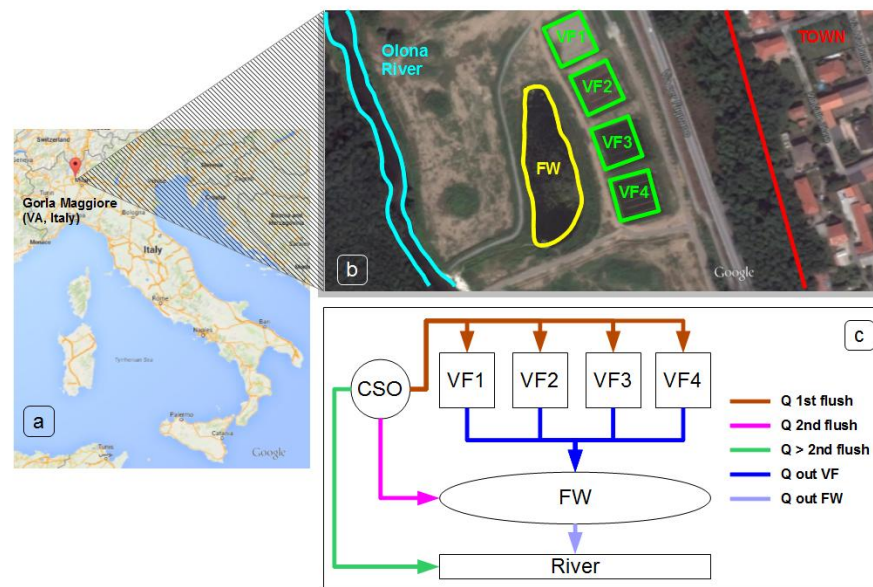
	m²
Poplar grove	0
Reed zones	3800
Wetland zones	3500
Buffer zones and trees	2000





# Gorla Maggiore case study: technical scheme

- CSO discharge repartition
  - treatment plant
  - **1<sup>st</sup> flush**
  - 2<sup>nd</sup> flush
- Pre-treatment
- 1<sup>st</sup> stage: French-**VF** CWs
  - 1<sup>st</sup> flush treatment
- 2<sup>nd</sup> stage: **FWS** CW
  - 1<sup>st</sup> flush treatment refinement
  - 2<sup>nd</sup> flush
  - **Buffer tank**



## Data sampling for OpenNESS project

- **CSO wastewater quantity**

- CSO event sampling
- every 15 min during CSO events

- **CSO wastewater quantity**

- Sampling protocol

**In VF:** since start of CSO event

5 samples in the first hour

**Out FWS:** after theoretical HRT (36 h)

5 samples every hour

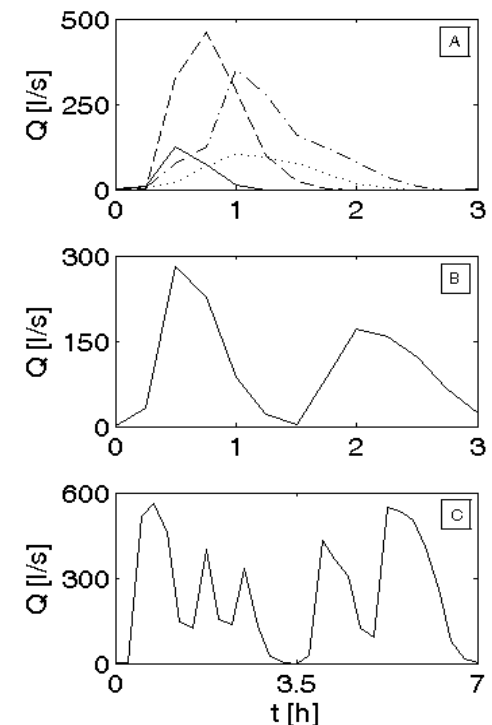
- 3 CSO samples done ( $\text{COD NH}_4^+$ )

- In VF – Out FWS spring
- In VF – Out FWS summer
- In VF – Out FWS winter

## Data Sampling: CSO quantity

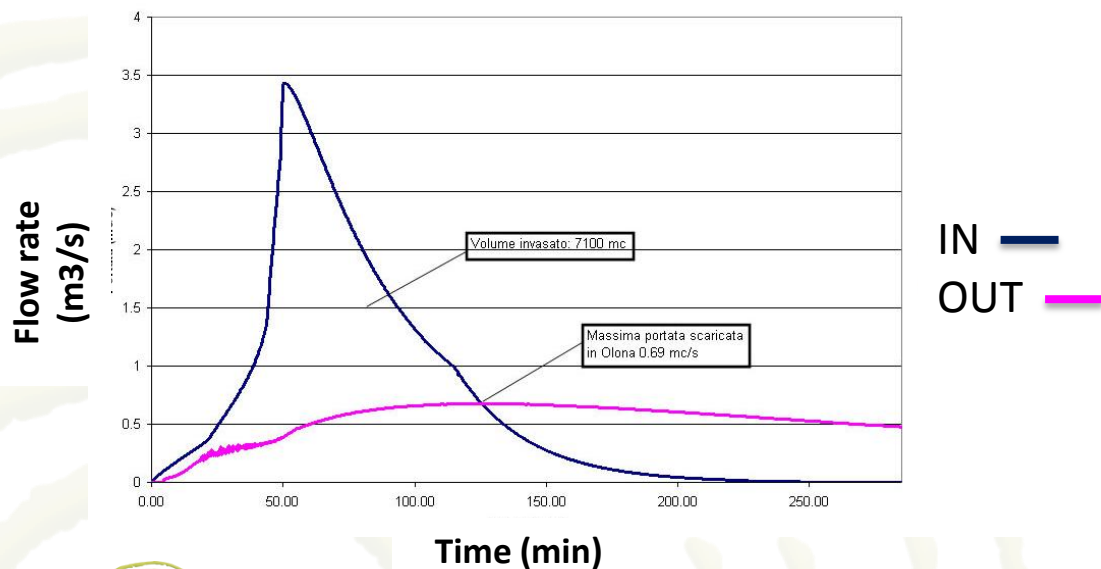
- 1 year CSO quantity characterization
  - From February 2014 to February 2015
  - 68 CSO events
  - Both singular or consecutive up and down

	Average values
Volume	$2392 \pm 3325 \text{ m}^3$
Discharge	$333 \pm 246 \text{ m}^3/\text{h}$
Duration	$7.6 \pm 9.7 \text{ h}$
Dry period	$11 \pm 50 \text{ d}$



## Flood protection effect

FWS has been designed to properly works as a buffer tank for the hydrograph with return time of 10 years





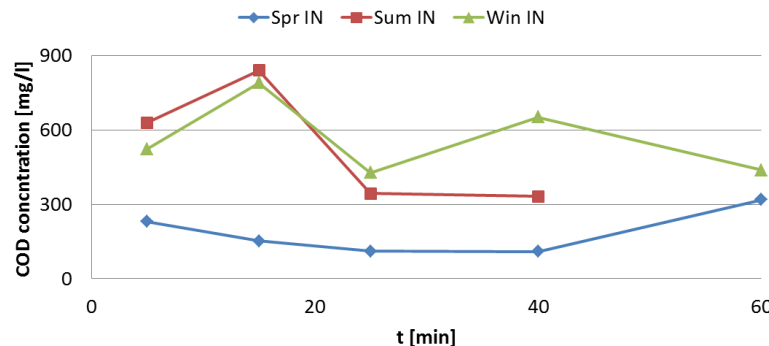
## Data Sampling: CSO quality – 1

- Satisfactorily low effluent concentrations
- Stochastic events

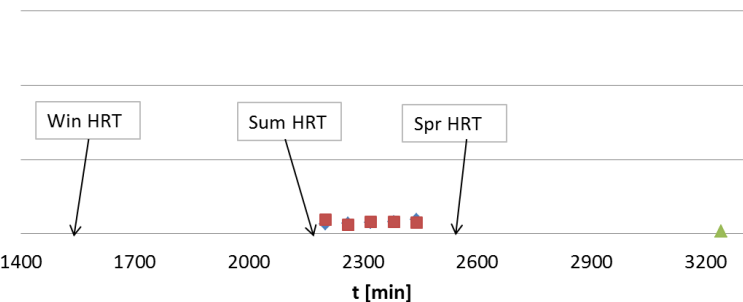
→ when should I sample? Efficiency calculation?

	IN	OUT
COD [mg/l]	394.0±218.9	41.1±1.0
N-NH <sub>4</sub> <sup>+</sup> [mg/l]	15.9±12.1	1.0±0.9

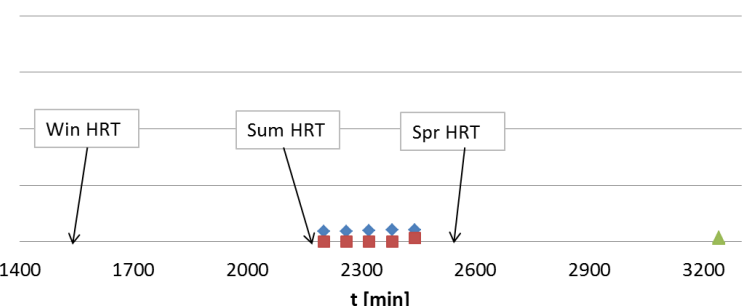
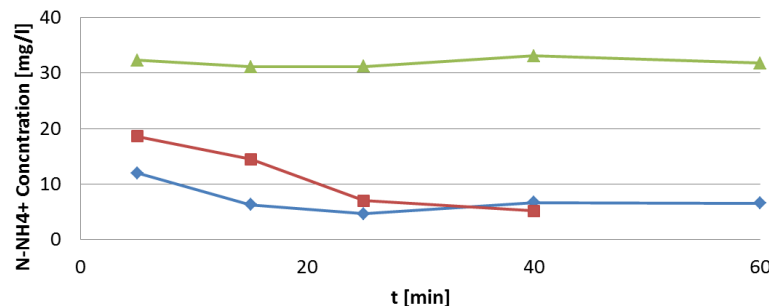
**COD**



◆ Spr OUT ■ Sum OUT ▲ Win OUT

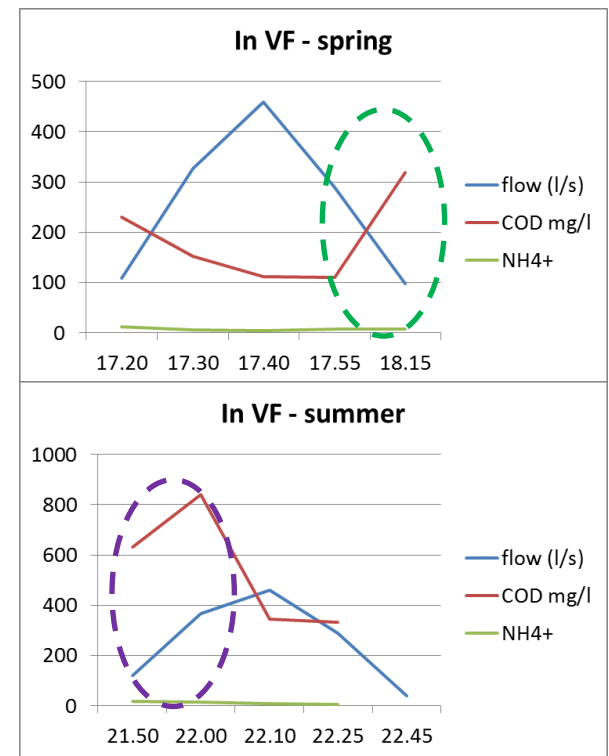


**N-NH<sub>4</sub><sup>+</sup>**



## Data Sampling: CSO quality - 2

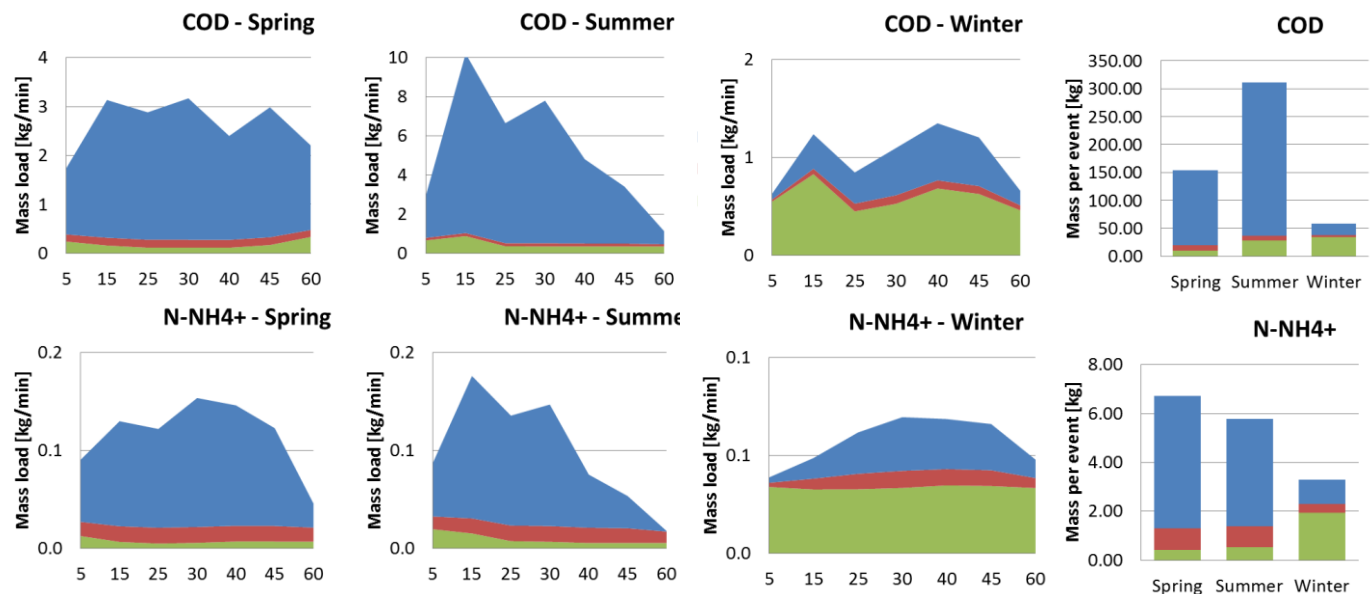
- Removal efficiencies VF+FWS (3 samples)
  - COD: 69-91%
  - $\text{NH}_4^+$  : 70-99%
- Removal efficiencies VF (1 sample)
  - COD: 89%
  - $\text{NH}_4^+$  : 87%
- 1<sup>st</sup> flush characterization
  - Higher concentration in first CSO phase
  - Possible higher concentration due to low flow at the end of CSO event



## Pollution control: Mass balance

- Black mass load → 2017 PE + literature values
- High first flush in Spring and Summer (↑↑ CSO volume)
- Lower but not negligible first flush also in Winter (↓↓ CSO volume)
- Loads to WWTP relevant only for ↓↓ CSO volume

■ CW first flush  
■ CW black water  
■ WWTP





# Wildlife support

Monitoring the pond and the river for macroinvertebrates, macrophytes, visible fauna and biochemical parameters (July 2014)



Fro





# Wildlife support

## Macroinvertebrates in the pond

*Chironomus riparius* (non-biting midges)  
(Insecta: Diptera)



- wide tolerance
- important source of food
- contribute to the oxygenation

Naididae  
(Annelida, Oligochaeta)



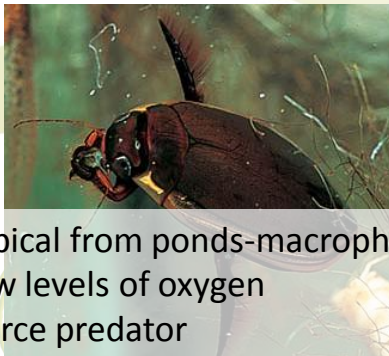
- anoxic sediments

Coenagrionidae  
(Insecta: Odonata)



- intermediate water quality
- carnivorous
- adults in the pond

Ditiscidae  
(Insecta: Coleoptera)



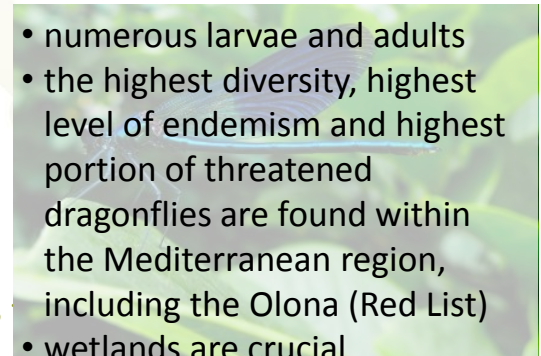
- typical from ponds-macrophytes
- low levels of oxygen
- fierce predator

Gerridae  
(Insecta: Heteroptera)



- typical from ponds
- intermediate-low water quality
- predator

Other Odonata  
(dragonflies & damselflies)



- numerous larvae and adults
- the highest diversity, highest level of endemism and highest portion of threatened dragonflies are found within the Mediterranean region, including the Olona (Red List)
- wetlands are crucial

epts

# Wildlife support

## Higher organisms observed in the pond

Rana verde  
*Rana synklepton esculenta*



Rana agile  
*Rana dalmatina*



Juvenile fish  
(Gambusia?)



Gallinella d'acqua (*Gallinula chloropus*)  
"Least concern" in the Red List



- densely vegetated wetlands

Airone cenerino (*Ardea cinerea*)  
"Least concern" in the Red List



Tarabuso (*Botaurus stellaris*)  
(protected by the EU Birds Dir.)



- vulnerable conservation state
- Special Protection Areas
- densely vegetated wetlands



# Wildlife support

## Macrophytes in the pond

Macrophytes were planted but their present vigour and distribution depend on the environmental conditions. Two well-developed plant zones:

- emerged macrophytes covering ca. 10% (dominated by *Typha angustifolia*)
- floating leaved plants in ca. 15% (dominated by *Nymphoides peltata* and *Nymphaea alba*)

No submerged plants (*Ceratophyllum* was planted but has not survived, most probably due to low water transparency).

Tifa o stiancia  
(*Typha angustifolia*)



Cannuccia di palude  
(*Phragmites australis*)



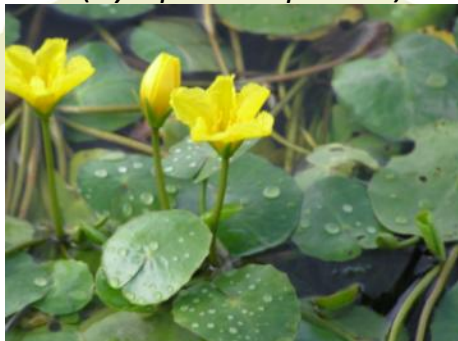
Gaggiolo acquatico  
(*Iris pseudacorus*)



Lisca lacustre  
(*Scirpus lacustris*)



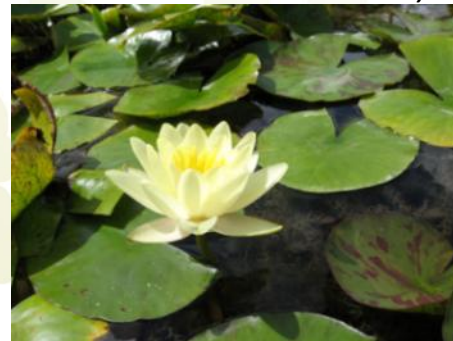
Limnantesio  
(*Nymphoides peltata*)



Ninfea comune  
(*Nymphaea alba*)



Ninfea a fiore giallo (*Nymphaea*  
*Marliacea Chromatella*)



Ceratofillo  
(*Ceratophyllum demersum*)



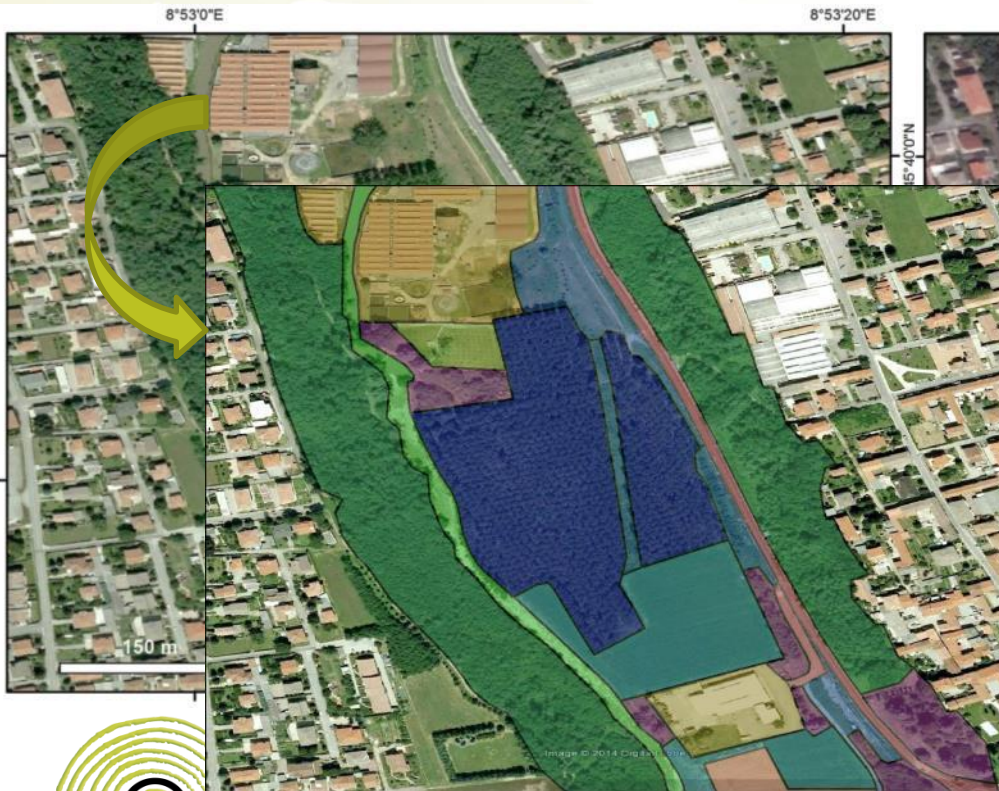


# Wildlife support

Habitats diversity index of the 3 alternatives

Software Fragstats (University of Massachusetts) for landscape metrics

2008



2012



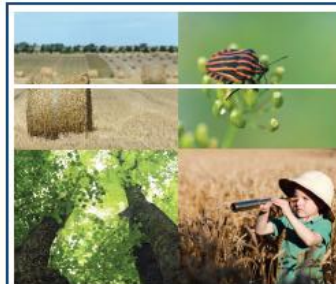


# Recreation

## Relevance for Gorla Maggiore and surroundings

### Questionnaire for local residents (ongoing):

- Number of visits and people
- Distance from home
- Activities
- Personal opinion



### L'opinione dei cittadini conta!

Questo questionario è parte di un progetto di ricerca scientifica sui benefici dell'ambiente per la società.

Il vostro contributo è importante per migliorare le decisioni future.

- Il questionario è anonimo. Le risposte saranno trattate in modo strettamente confidenziale.
- Il questionario può essere compilato on-line sul sito web <http://ec.europa.eu/eusurvey/runner/GorlaMaggiore> o su forma cartacea entro il 28 febbraio 2014. In questo secondo caso vi chiediamo di consegnare il questionario compilato al Comune di Gorla Maggiore.
- Vi chiediamo cortesemente di rispondere a tutte le domande con attenzione. Completare il questionario non richiederà più di 20 minuti.

### Il parco di Gorla Maggiore e me

Il Parco di Gorla Maggiore si trova sulla riva del fiume Olona in via Per Fagnano, molto vicino al centro del paese. E' costituito da un'area umida e un laghetto artificiali (impianto verde) e un parco ad uso ricreativo.

L'impianto verde è stato costruito per ridurre l'inquinamento delle acque reflue della municipalità di Gorla Maggiore verso il fiume Olona. In tempo secco le acque di fogna del comune di Gorla sono trattate dal depuratore centralizzato di Olgiate Olona. Ma in caso di eventi di pioggia consistenti la rete fognaria non può raccogliere tutte le acque reflue e quindi una porzione degli scarichi è trattata dall'impianto verde di Gorla, mentre in passato era versata direttamente nel fiume.

In più il laghetto e l'area circostante raccolgono temporaneamente l'acqua rallentando l'onda di piena nel fiume Olona. Il parco inoltre offre la possibilità di svolgere attività ricreative all'aria aperta e il livello di biodiversità dell'area è considerato elevato.



1. Quante volte lei ha visitato il Parco di Gorla Maggiore negli ultimi 12 mesi (in media)?

- |  |   |
|--|---|
| <input type="checkbox"/> Mai                   | <input type="checkbox"/> Circa 2 volte al mese      |
| <input type="checkbox"/> Solo 1 volta          | <input type="checkbox"/> Circa 3 volte al mese      |
| <input type="checkbox"/> 1 - 5 volte           | <input type="checkbox"/> Circa 1 volta a settimana  |
| <input type="checkbox"/> 5 - 10 volte          | <input type="checkbox"/> Circa 2 volte a settimana  |
| <input type="checkbox"/> Circa 1 volta al mese | <input type="checkbox"/> Più di 2 volte a settimana |

2. Tipicamente con quante persone si reca al Parco di Gorla (famigliari o amici) includendo se stesso?

- |   |   |
|---|---|
| <input type="checkbox"/> Di solito vado da solo | <input type="checkbox"/> Di solito siamo in 4     |
| <input type="checkbox"/> Di solito siamo in 2   | <input type="checkbox"/> Di solito siamo in 5     |
| <input type="checkbox"/> Di solito siamo in 3   | <input type="checkbox"/> Di solito siamo più di 5 |

3. Quanto dista la sua abitazione dal Parco di Gorla?

- |   |  |
|---|--|
| <input type="checkbox"/> Meno di 500 metri    | <input type="checkbox"/> Tra 2-3 chilometri  |
| <input type="checkbox"/> Tra 500 e 1000 metri | <input type="checkbox"/> Più di 3 chilometri |
| <input type="checkbox"/> Tra 1-2 chilometri   |  |

4. Per le seguenti attività ricreative, può indicare quanto spesso le pratica quando visita il Parco di Gorla:

	Spesso	Qualche volta	Mai
Passeggiare / passeggiare con il cane	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Correre / Andare in bicicletta	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Educare i bambini alla natura	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Far giocare i bambini	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Picnic (mangiare)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Guardare gli animali (uccelli, rane,...)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Piacere di stare nella natura	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Prendere il sole	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Altro:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Le piace il Parco di Gorla?

- |                                     |                                 |
|-------------------------------------|---------------------------------|
| <input type="checkbox"/> Molto      | <input type="checkbox"/> Poco   |
| <input type="checkbox"/> Abbastanza | <input type="checkbox"/> Non sa |



# Construction costs

<b>green infrastructure</b>	
constructed wetland - vertical flow systems	€ 222.459
constructed wetland - free water system	€ 92.941
pre-treatments (automatic screen, grit removal)	€ 111.014
pipelines	€ 69.361
earthmovings	€ 54.616
Monitoring equipments	€ 49.266
Combined sewer overflow structures	€ 88.307
second flush pipeline	€ 20.938
Outlet structures	€ 19.874
outlet protection and river restoration	€ 38.845
Ancillary works	€ 25.592
safety plan works	€ 26.785
Landscaping	€ 80.000
	<b>€ 900.000,00</b>

<b>grey infrastructure</b>	
first flush tank 1000 m3	€ 500.000
pipelines	€ 20.000
earthmovings	€ 45.000
Monitoring equipments	€ 15.000
Combined sewer overflow structures	€ 88.307
second flush pipeline	€ 20.938
Outlet structures	€ 19.875
outlet protection and river restoration	€ 38.845
Ancillary works	€ 20.000
safety plan works	€ 26.785
Landscaping	€ 50.000
	<b>€ 844.749,24</b>

# O&M costs

green infrastructure	designed	Real (1°-3° year)	Note
constructed wetland - reeds maintenance	€ 1.360	€ 0	no cutting due to slow grow rate
automatic screen, solids disposal	€ 200	€ 200	
grit removal, sand extraction and disposal	€ 2.800	€ 1867	no extraction till now, total emptying scheduled for this year
power consumption	€ 50	€ 50	
monitoring analysis (2 x year)	€ 600	€ 0	analysis funded by Lombardia Region
Landscaping maintenance	€ 5.600	€ 1000	landscaping mainly done by volunteers
manwork for inspection activities	€ 2.700	€ 500	municipal workers + little electrical operations
	<b>€ 13.210</b>	<b>€3.617</b>	

grey infrastructure	
cleaning, sediment extraction and disposal	€ 1.500
power consumption	€ 500
elettromechanical equipments maintenance	€ 200
Landscaping maintenance	€ 3.600
manwork for inspection activities	€ 1.350
Main WWTP treatment cost (0,25 €/m3)	€ 8.250
	<b>€ 15.397</b>



# Indicators and alternatives

Objectives	Criteria	Indicators	Alternatives		
			Poplar plantation	Grey infrastruc	Green infrastruc
<b>People safety</b>	Reduce flooding risk	Peak flow reduction (%), return time of 10 years	0	80	86
		Reduction of flooding downstream (m3), return time of 10 years	0	8 100	8 900
<b>Water quality</b>	Reduce pollution load	Load reduction of dissolved organic carbon (t/yr)	0	9.5	11.7
		Load reduction of nitrogen (t/yr)	0	0.2	0.4
<b>Wildlife support</b>	Provide a healthy natural habitat	Expert judgment about biodiversity	low	low	high
		Landscape diversity (Shannon's diversity index)	1.89	1.85	2
<b>People recreation and health</b>	Provide green space for recreation	No. of visitors/users	0	moderate-high*	high*
		Frequency of visits	0	moderate-high*	high*
<b>Market goods</b>	Timber exploitation	Value of timber production (profit from harvest in EUR)	ca. 21 420	0	0
<b>Public costs</b>	Reduce public costs	Total construction costs (EUR)	0	844 750	900 000
		Total management costs (EUR/yr)	0	15 396	13 210
		Expected lifespan (yr)	17	20	20
		Area occupied (ha)	36 000	2 000	9 300

# Conclusions

- Green option gives better performance for most of criteria
- Comparable construction costs between Green and Grey
- Green option shows lower cost per m<sup>3</sup> of treated water (higher volume treated)

## Further possible studies

- Evaluate alternatives considering other criteria (e.g. LCA)
- Expand analysis at basin scale to support decision-maker (can CSO-CWs contribute to flood protection?)