INNOQUA
innovation for wastewater treatment

Webinar: Earthworms, water fleas and algae: the future of wastewater treatment?

17◦ of November 2020

Innovative NBS for the future smart and circular cities

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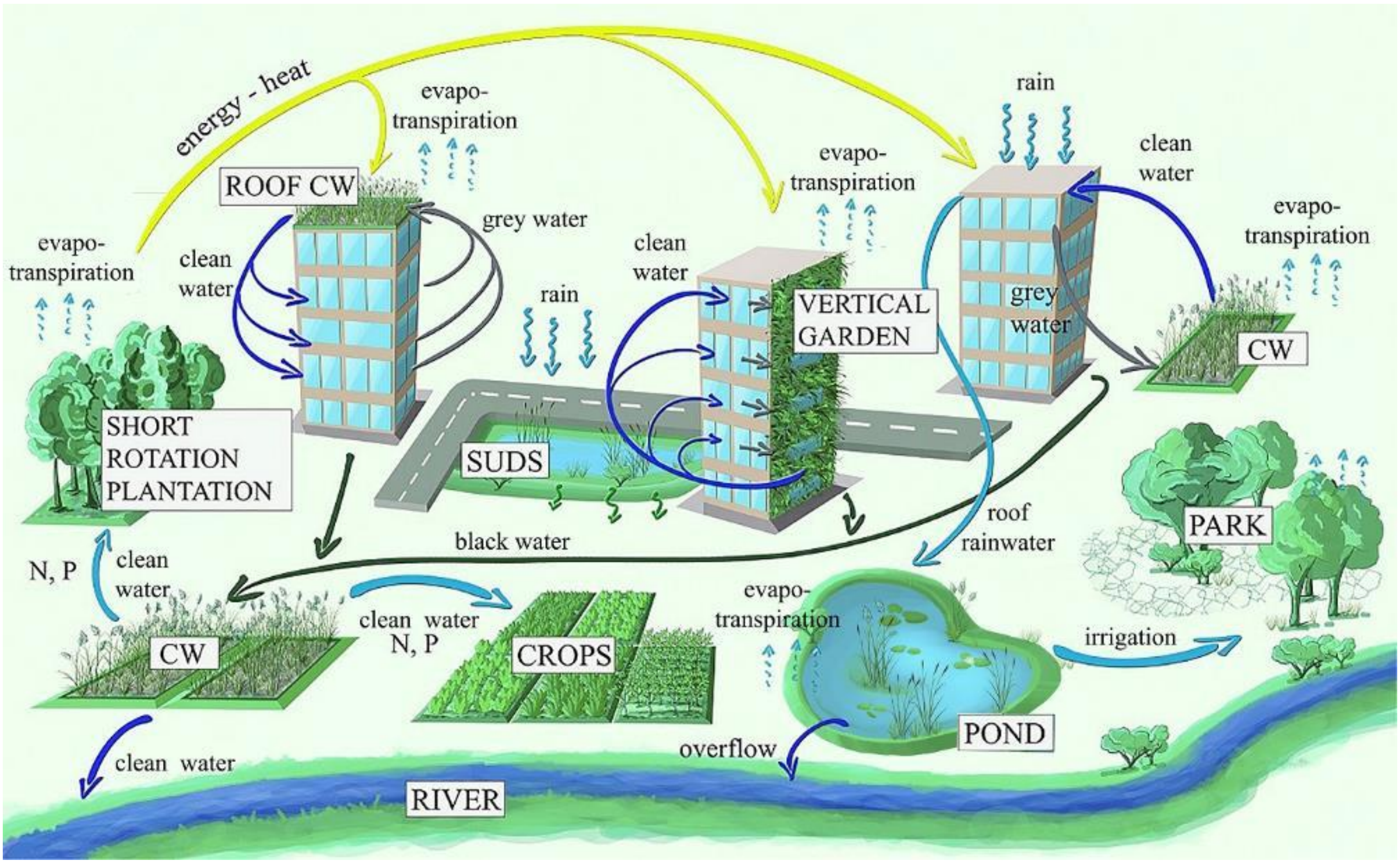
IRIDRA


energy - heat
evapo-
transpiration
ROOF CW
grey water
clean
water
evapo-
transpiration
rain
clean
water
evapo-
transpiration
VERTICAL
GARDEN
rain
clean
water
grey
water
evapo-
transpiration
CW
SHORT
ROTATION
PLANTATION
SUDS
black water
roof
rainwater
PARK
N, P
clean
water
clean water
N, P
CW
CROPS
evapo-
transpiration
irrigation
POND
overflow
clean water
RIVER

1. Aerated wetlands (AEW)

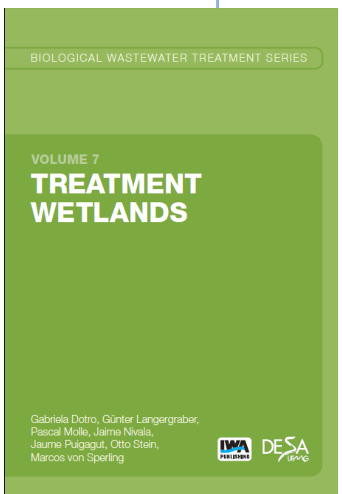
IRIDRA S.r.l.

Sizing
AEW

- **NO SOIL!!!!**
- Aeration system on the bottom
- Possibility to feed both as HF or as VF
- **Gravel** of selected size, typical height 1.0 m
- waterproofed
- Typically planted with *Phragmites australis*
- **Reduction of area requirement up to 4-5 in comparison to conventional solutions**

Advantages of AEW in comparison to conventional CW	AEW	Conventional CW
N°1 : area requirement	1 m^2/pe	3 m^2/pe

Sizing
AEW



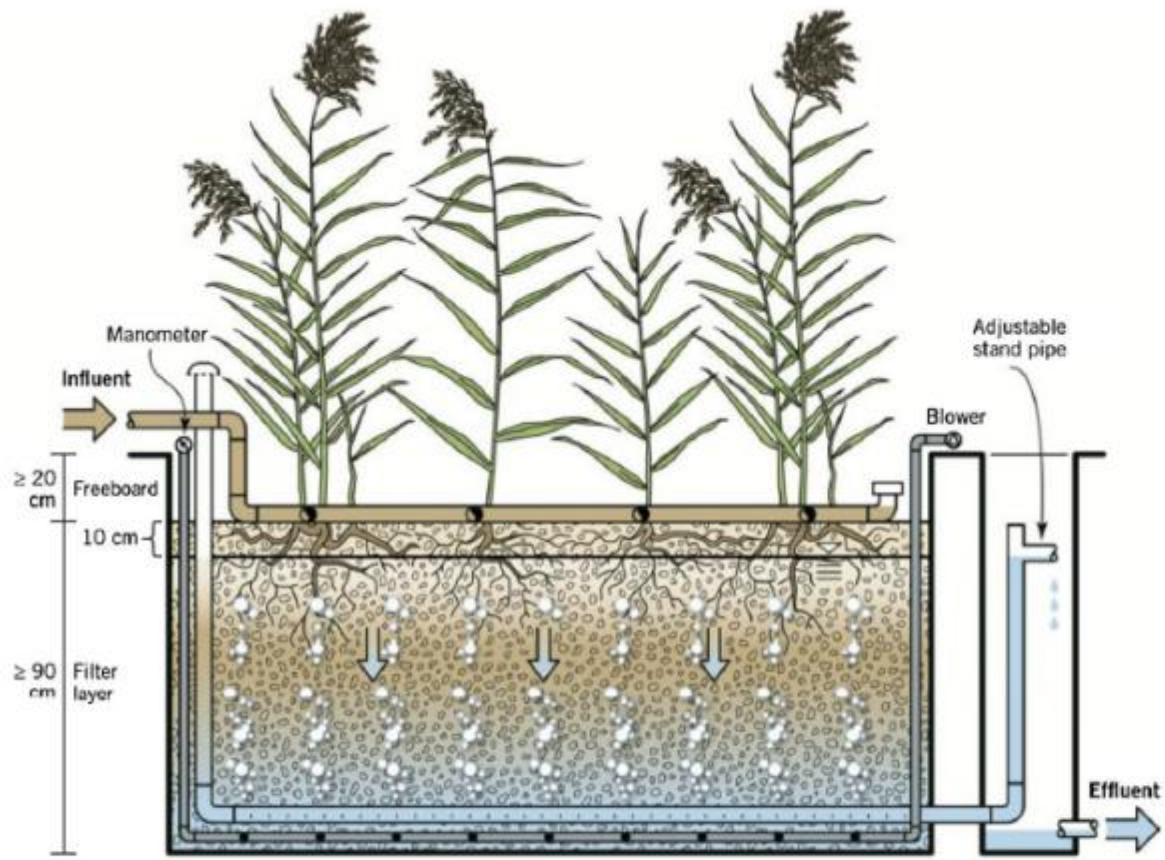
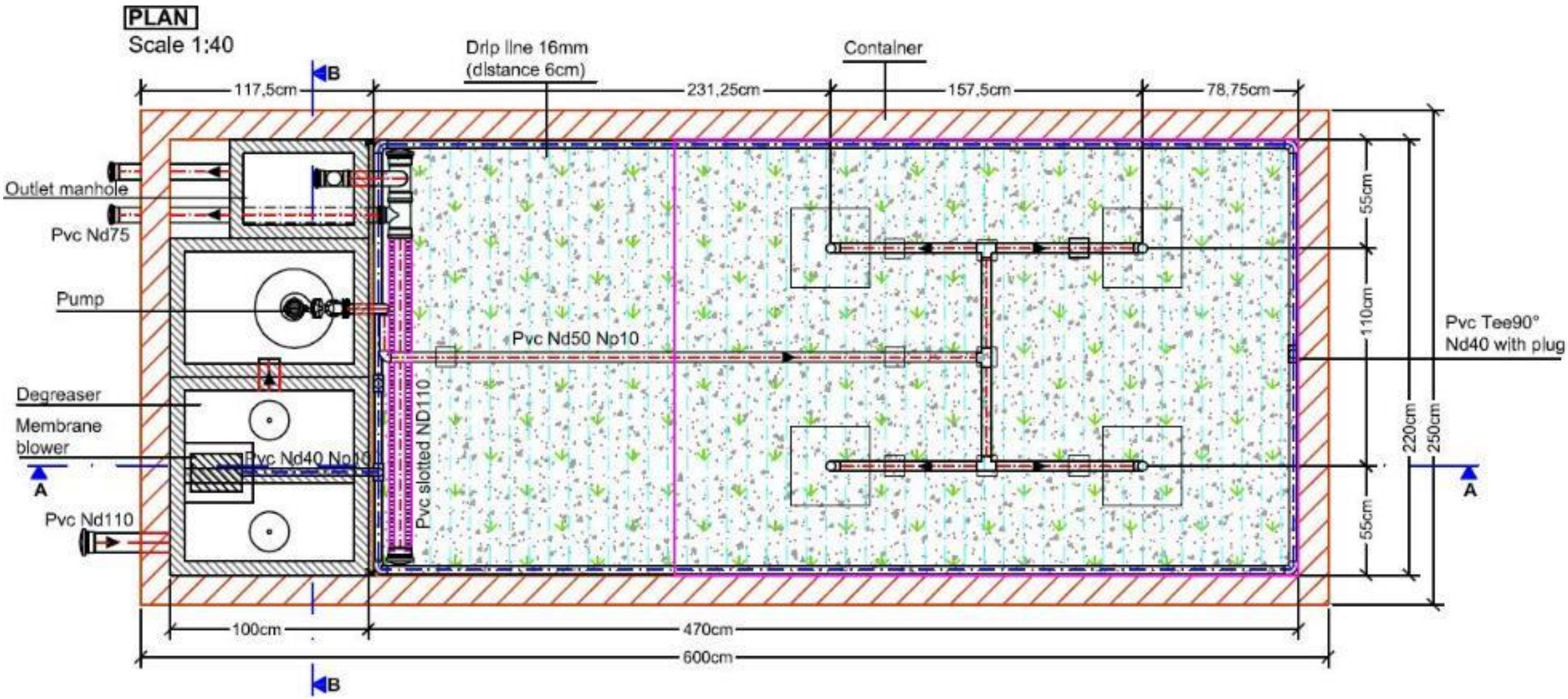


Figure 6.1 Schematic of an aerated wetland: VF.

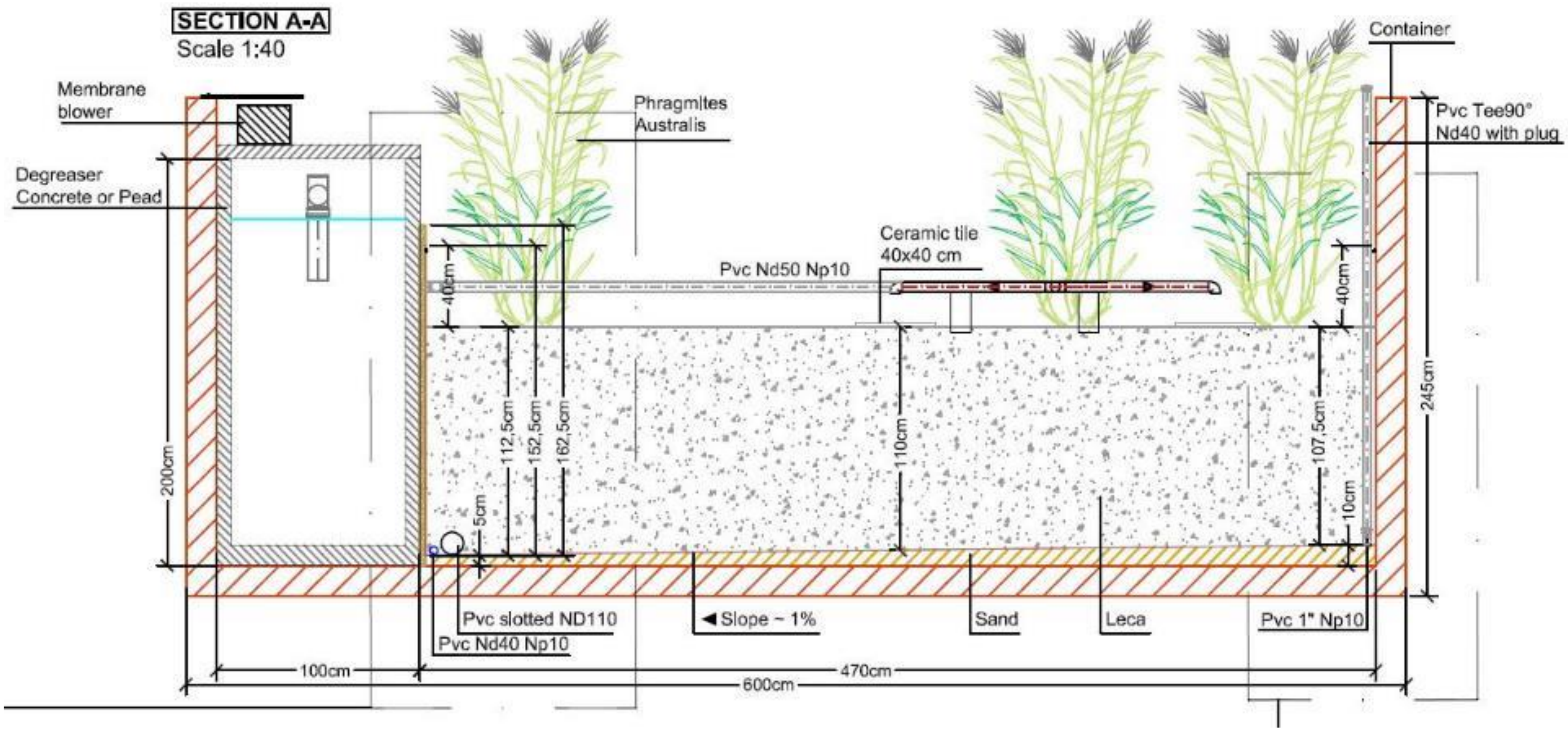
NAWAMED application

portable AEW for refuge camps: plan



NAWAMED application

portable AEW for refuge camps: section



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New design in implementation

Forced aeration

Compact
Better performances
Adaptation to loads variations

0.8 – 1 m^2 / P.E

French American system

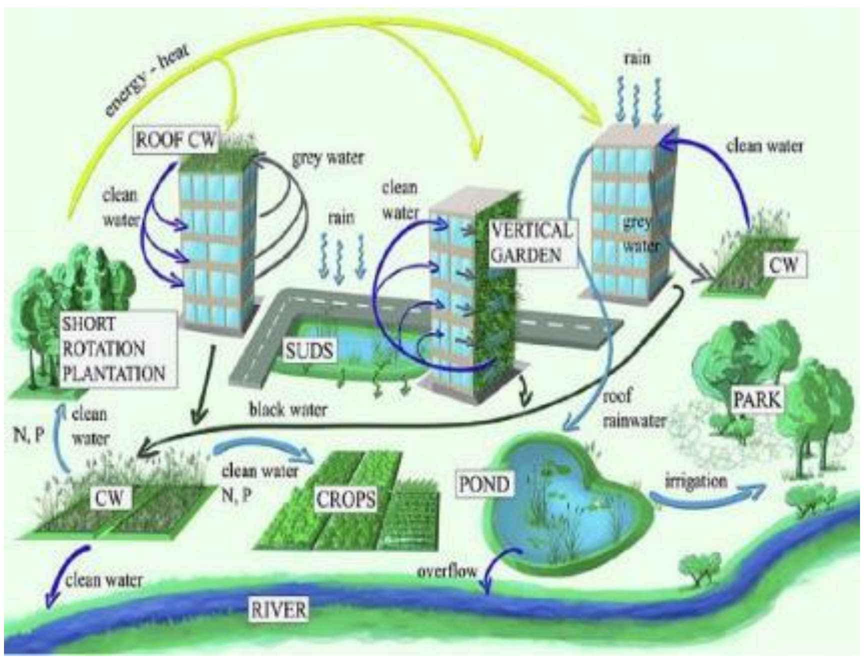
To improve ponds effluents

Aerated Rock Filter

2. Green walls

Why greywater recycling?

- **Greywater (GW):**
  - is the portion of household wastewater that excludes toilet flushes (and possibly kitchen sinks);
  - accounts **for up to 70% of domestic wastewater** (in EU: 100-150 L/day/PE).
- **Advantages** of GW separation and treatment:
  1. smaller volumes of (more polluted) wastewater are sent to treatment plants;
  2. treated GW can be recycled for other uses (e.g., WC flushing, irrigation).




Contents lists available at ScienceDirect
Journal of Environmental Management
journal homepage: www.elsevier.com/locate/jenvman
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Research article

The role of constructed wetlands in a new circular economy, resource oriented, and ecosystem services paradigm

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Motivation

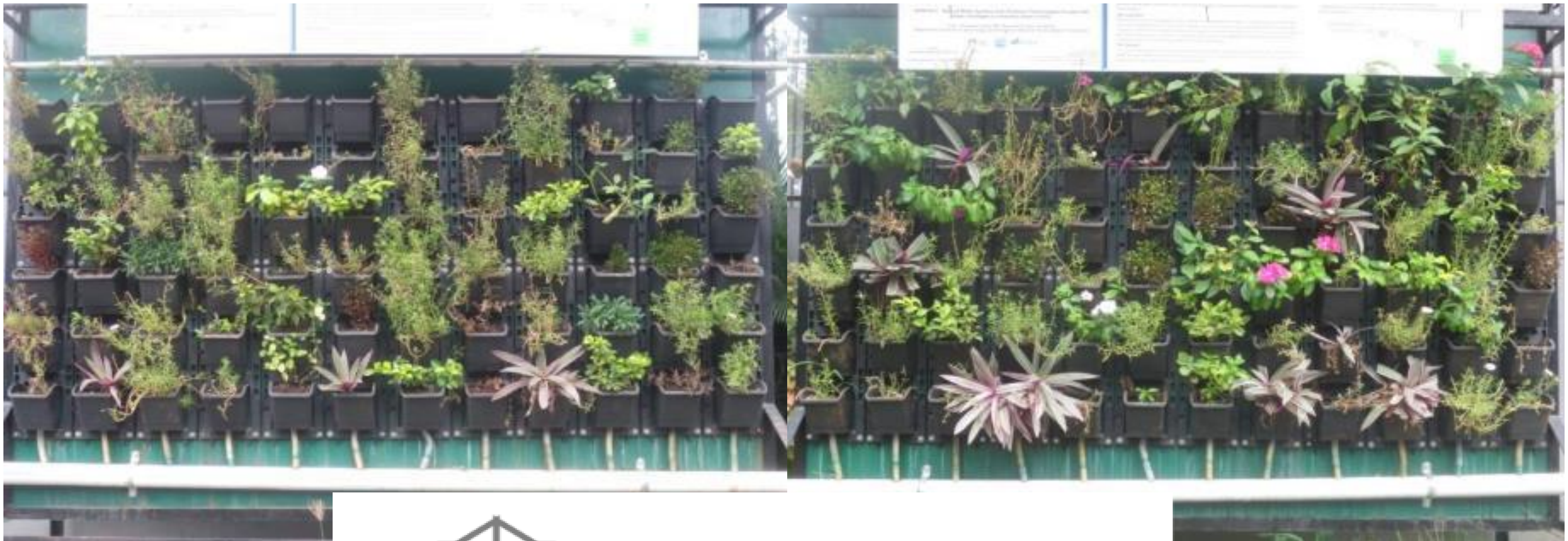
❑ **Green walls:**

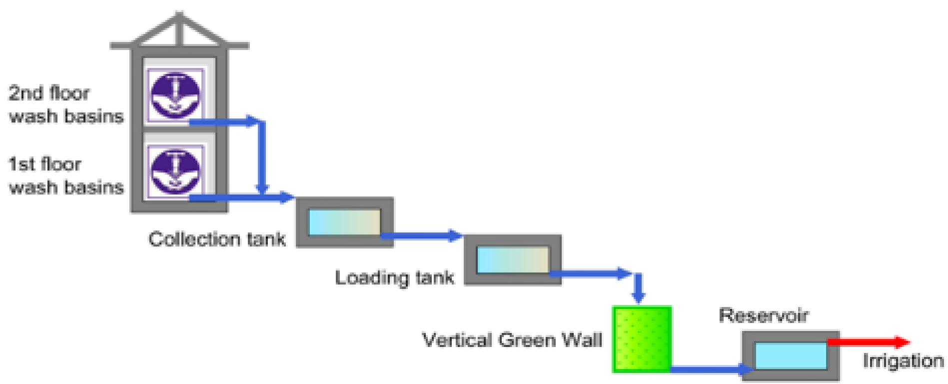
- Nature-based solutions with multiple benefits (aesthetics, thermal regulation, noise reduction…)
- can be built on unused vertical surfaces (good for urban areas);
- require considerable amounts of water for irrigation;

GREEN WALLS / VERTICAL GARDENS

- Air filtration + O_2 production and CO_2 storage
- Reduced energy costs + positive microclimate effects
- Increased biodiversity
- Reduced noise pollution
- Increased building longevity
- Aesthetics
- Wastewater treatment?

Maharashtra Jeevan Pradhikaran (PUNE) VERTICAL GARDEN FOR GW TREATMENT - experimental setup





Mjp pune results - 2

- Removal performances: mean values + (min-max)

	% removal	# of samples
COD	53 (14-86)	12
BOD_5	54 (15-86)	12
NH_4^+	52 (21-88)	12
TKN	24 (8-48)	12

- **Footprint**
  1 m^2 of greenwall per person – about 5-6 m^2 of external walls for an Indian family
- **Costs**
  About 600-800 USD for an Indian family (including degreaser, pumps, piping)
- **Economically feasible: payback time about 10-12 years**

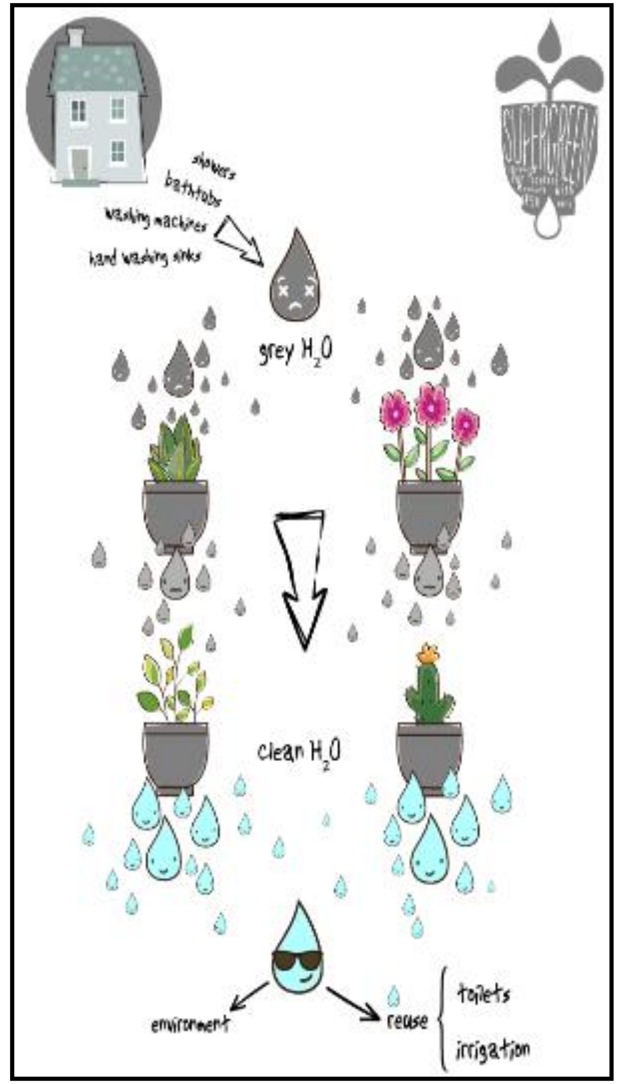
SUPERGREEN

- The idea of **SUPERGREEN** (*SUstainable Purification of greywatER with GREEN walls*) project is to test a system for treatment and reuse of greywater in urban areas.

- The system consists of **vertical green walls** composed of **modular panels** to exploit unused surfaces of buildings.

- Information on performance of green walls irrigated with GW is still limited

We performed **laboratory tests** at Politecnico di Torino aimed to **quantify the system performance in removing contaminants.**



Laboratory setup

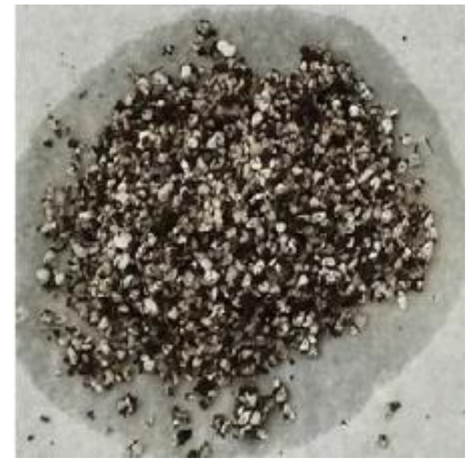
- **Base medium:** Different **mixes of coconut coir (C) and perlite (P)** (Prodanovic et al., 2018) were tested to identify a good compromise between drainage time and specific weight.


Coconut


Perlite

TESTED MIXES:

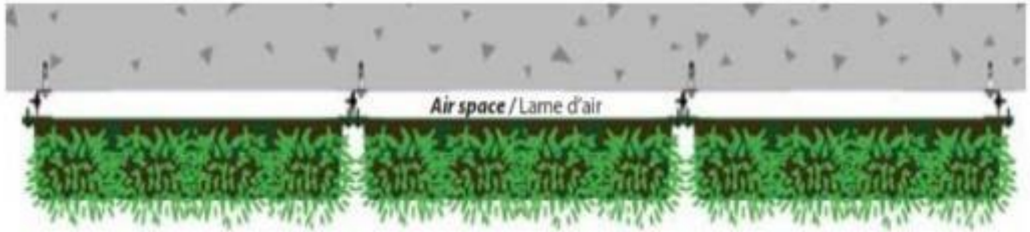
- 90% C – 10% P
- **80% C – 20% P**
- 70% C – 30% P
- 60% C – 40% P

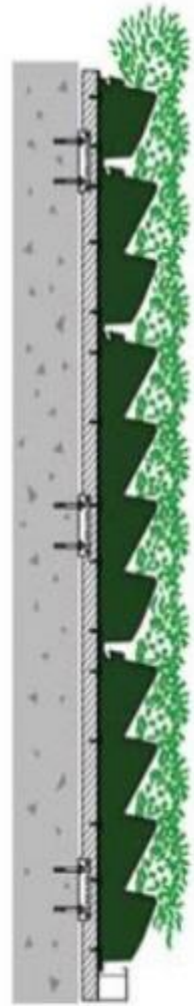


- The introduction of **additional materials** for enhancing treatment was also tested:
  - compost: 20%
  - polyacrylate (hydrogel): 20%
  - biochar: 20%
  - biochar + polyacrylate: 20% + 20%
  - activated carbon: 10%

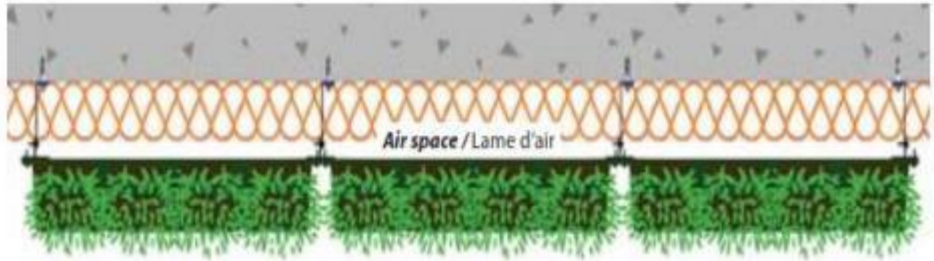
Supergreen Conclusions

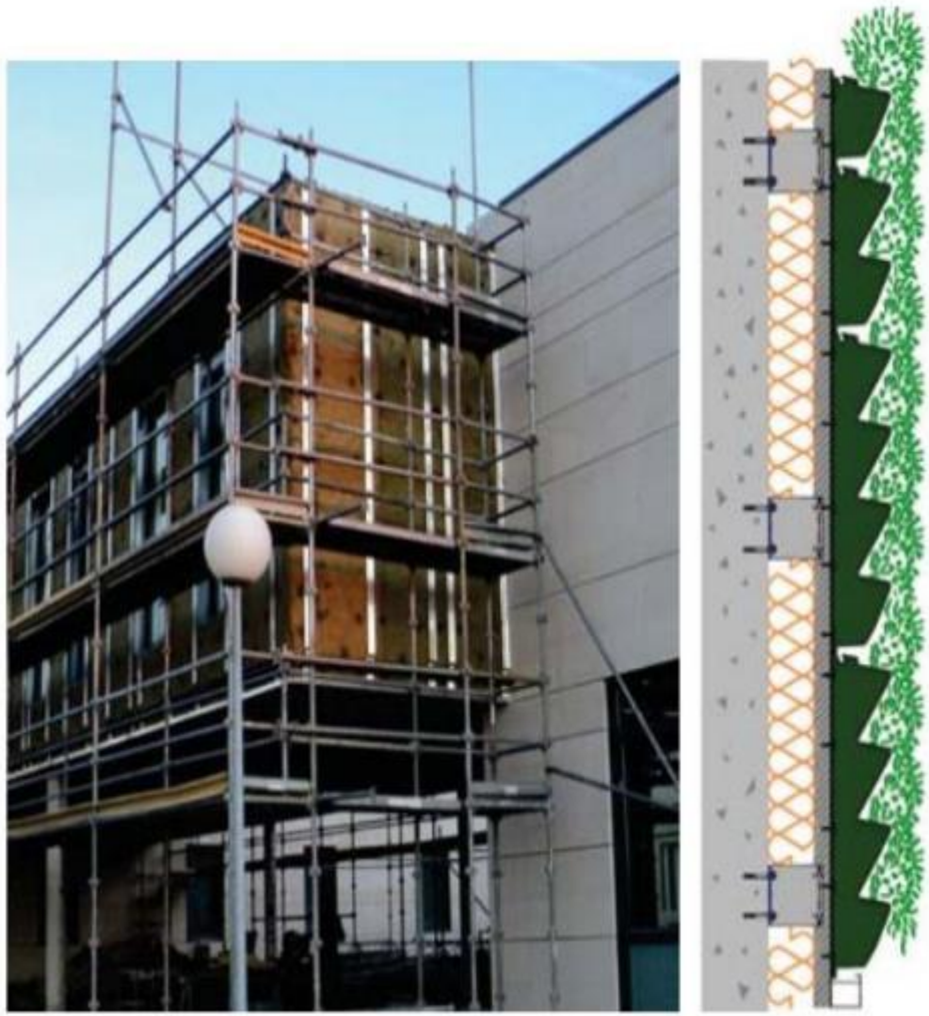
- Our pilot system was tolerant to GW up to HLR=700 L/m^2/d (very high, VF CW usually designed for 80 L/m^2/d)
- The best performance was achieved for BOD and E. coli, with removal efficiency close to 100%.
- COD removal was initially lower but increased over time (possibly due to biological effects).
- TN and TP show limited removed, but inflow concentrations were low.
- In view of Italian legislation limit
  - COD, BOD5, and TN met
  - E.Coli not met even with very high efficiencies → tertiary disinfection unit (e.g. UV lamp) needed, as usually done for reuse of wastewater treated by NBSs
  - TP peaks could be responsible of not fulfilling of reuse standard → possibility to use high-sorbent material need to be investigated
- COD, BOD5, TN, and TP releases must be properly accounted in the design phase if the proposed BM is used
- Removal efficiency (e.g., COD) may improve by adding biochar (and polyacrylates)





Implementation without insulation





Implementation with insulation

a - Regulating dripline

b - growing medium

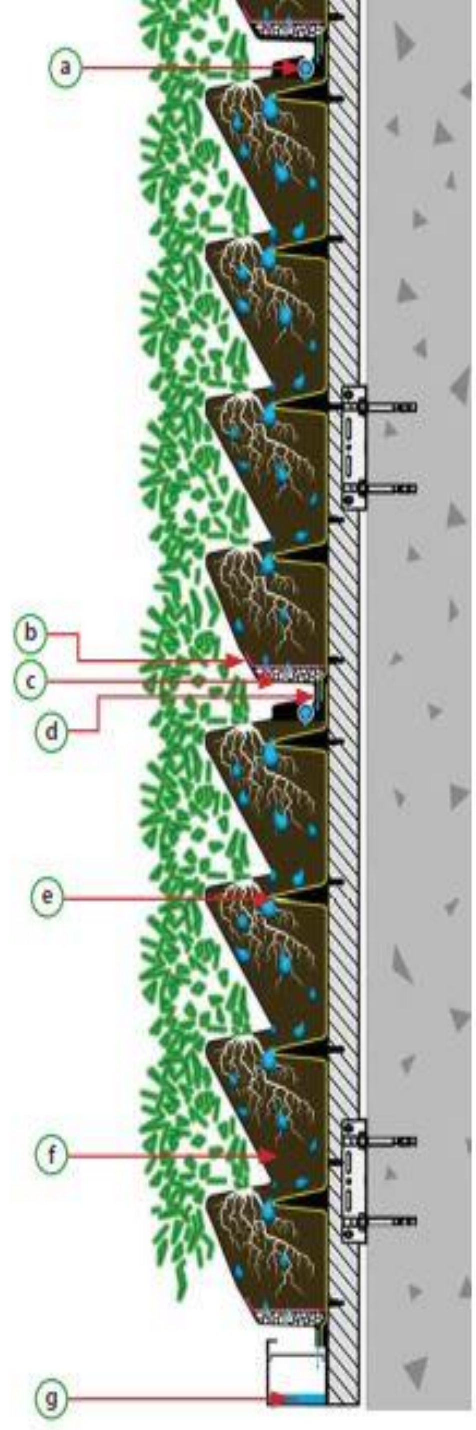
c - drainage medium

d - water evacuation

e - internal water distribution

f - growing medium

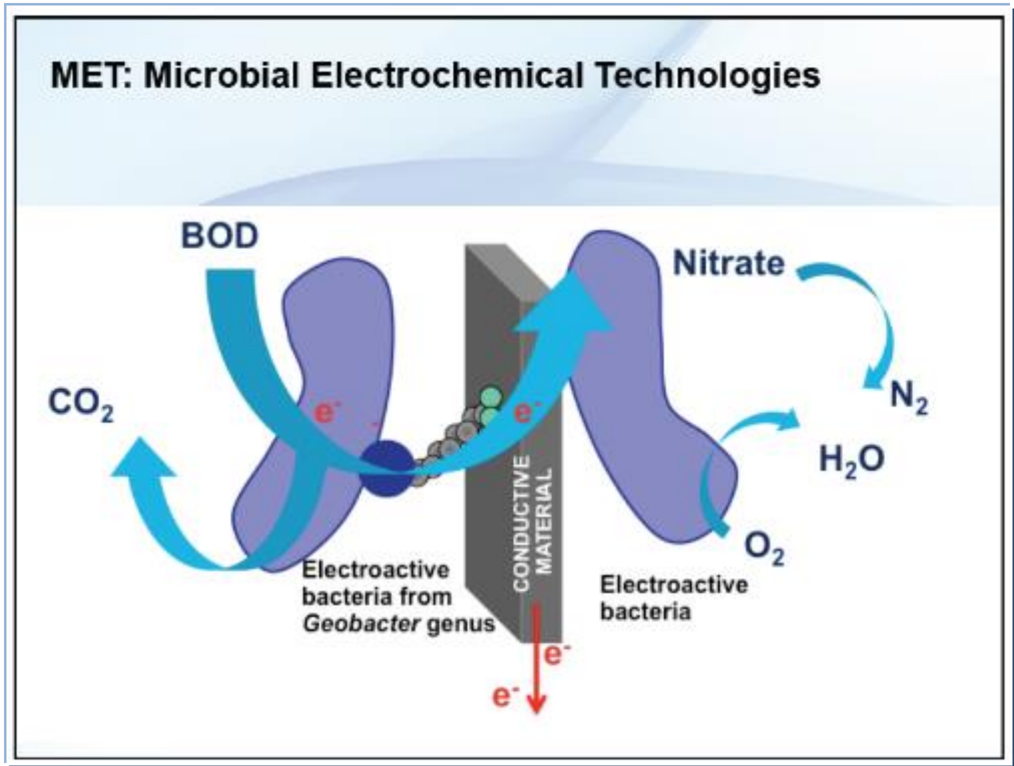
g - water recovery

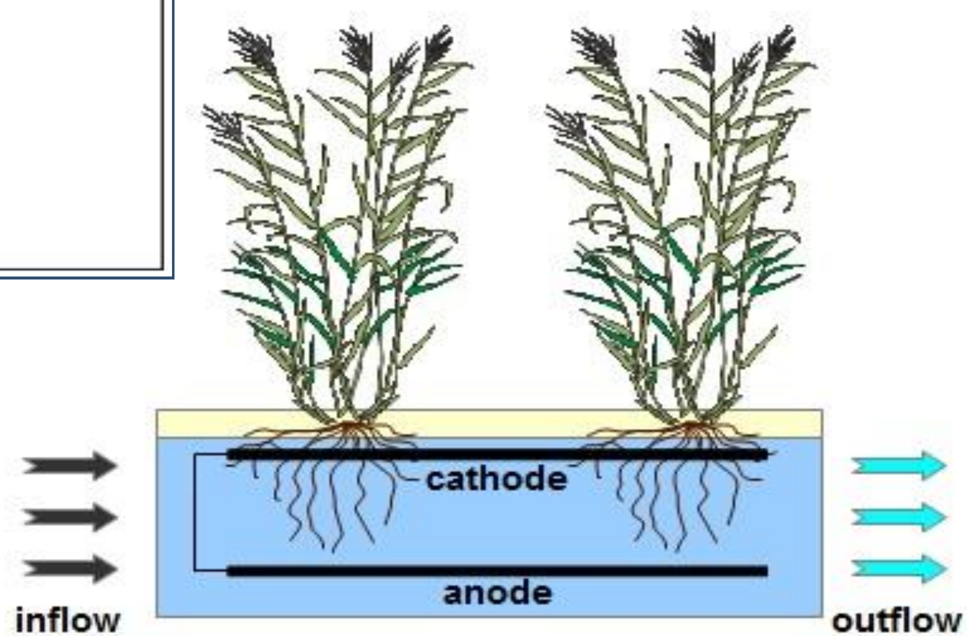


Rooftop Wetlands

2. Electrified CWs

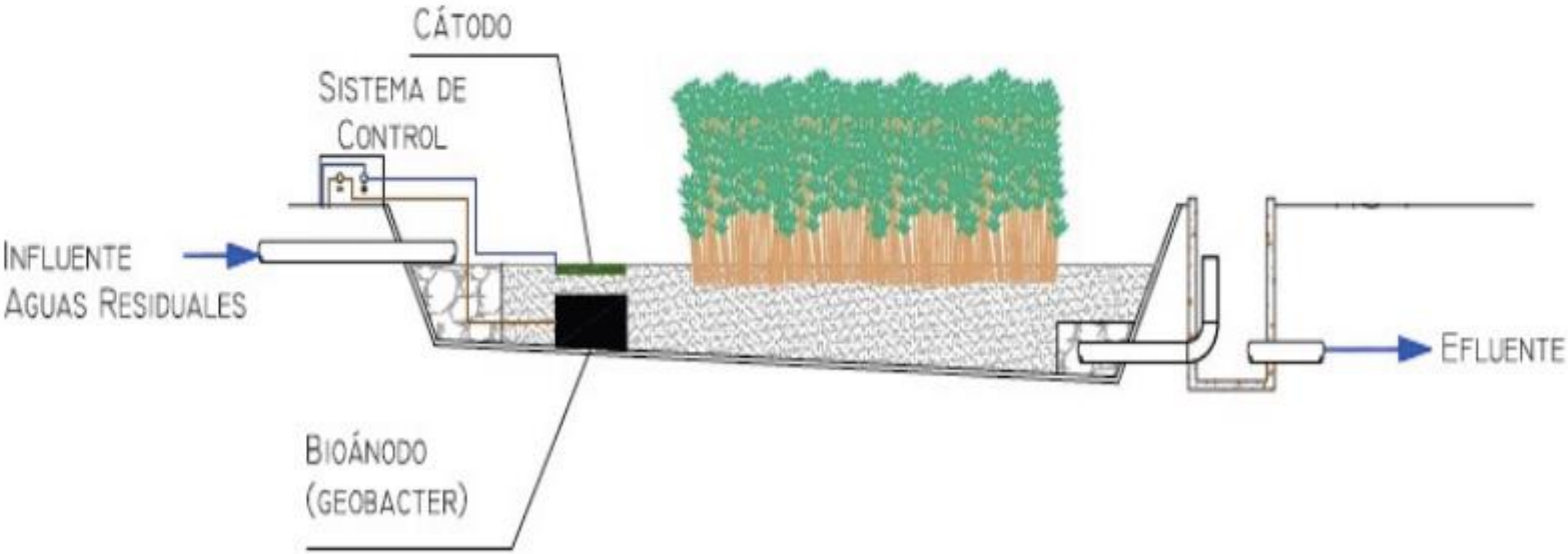
Microbial Fuel Cells - CWs





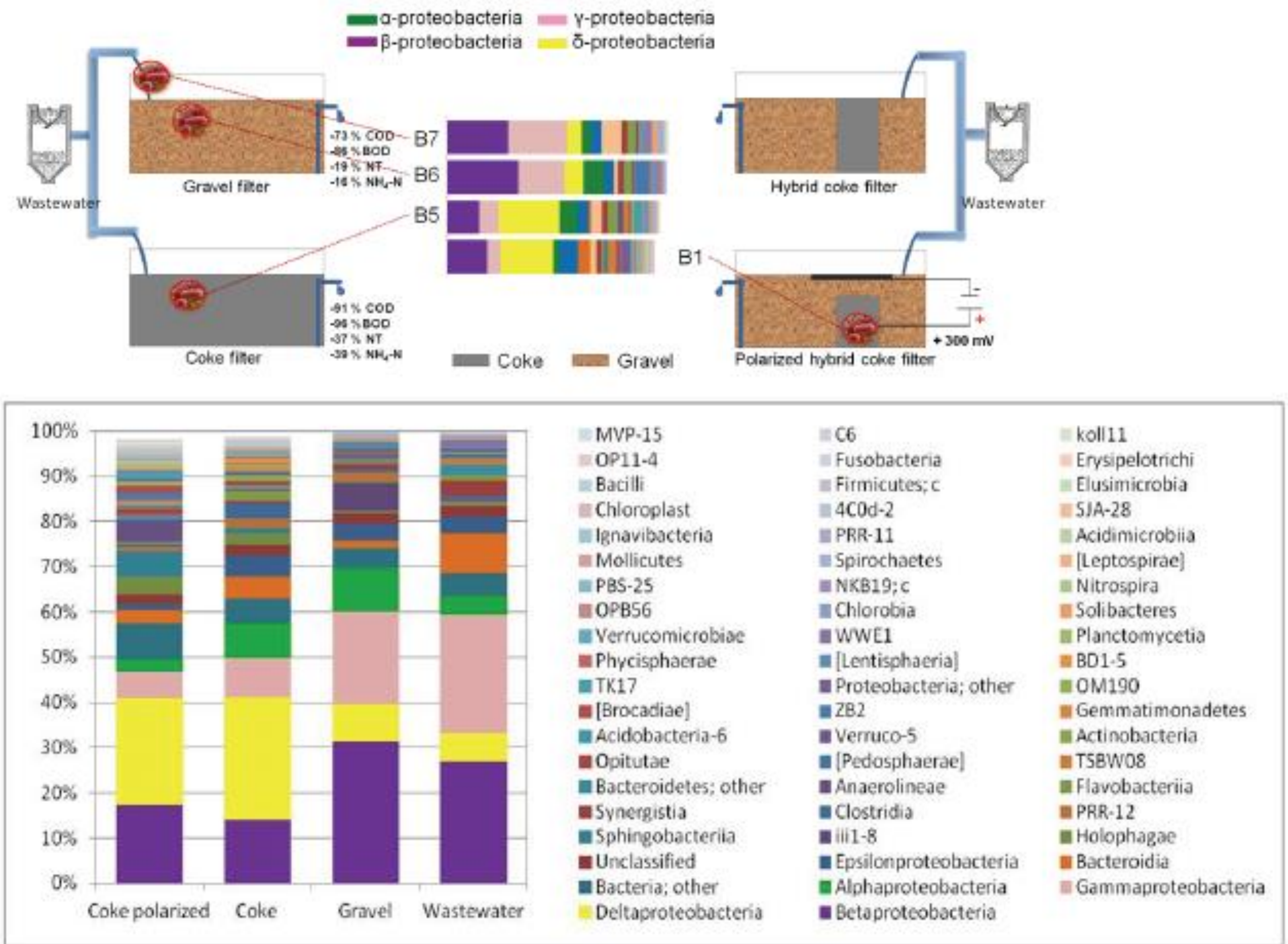
Bioelectrochemically assisted wetland

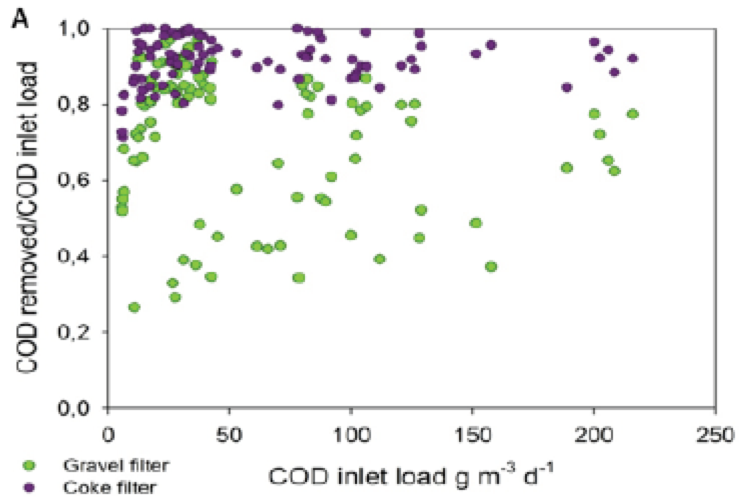
MET + WETLAND = METland



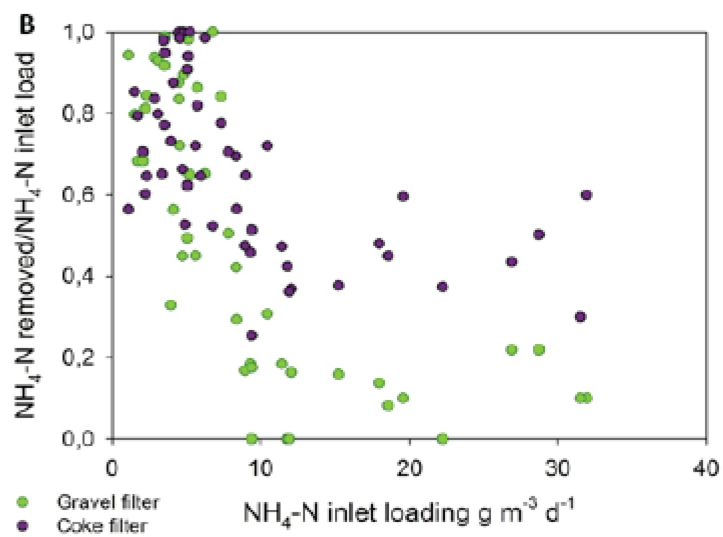
Esteve-Núñez et al. 2014. Long-term demonstration of a Bioelectrochemically constructed wetland for urban wastewater Treatment. 11th IWA Leading Edge Conference on Water and Wastewater Technologies, 26-30 mayo, Abu Dhabi

Horizontal METlands





>90% COD REMOVAL AT HIGH LOADING RATE

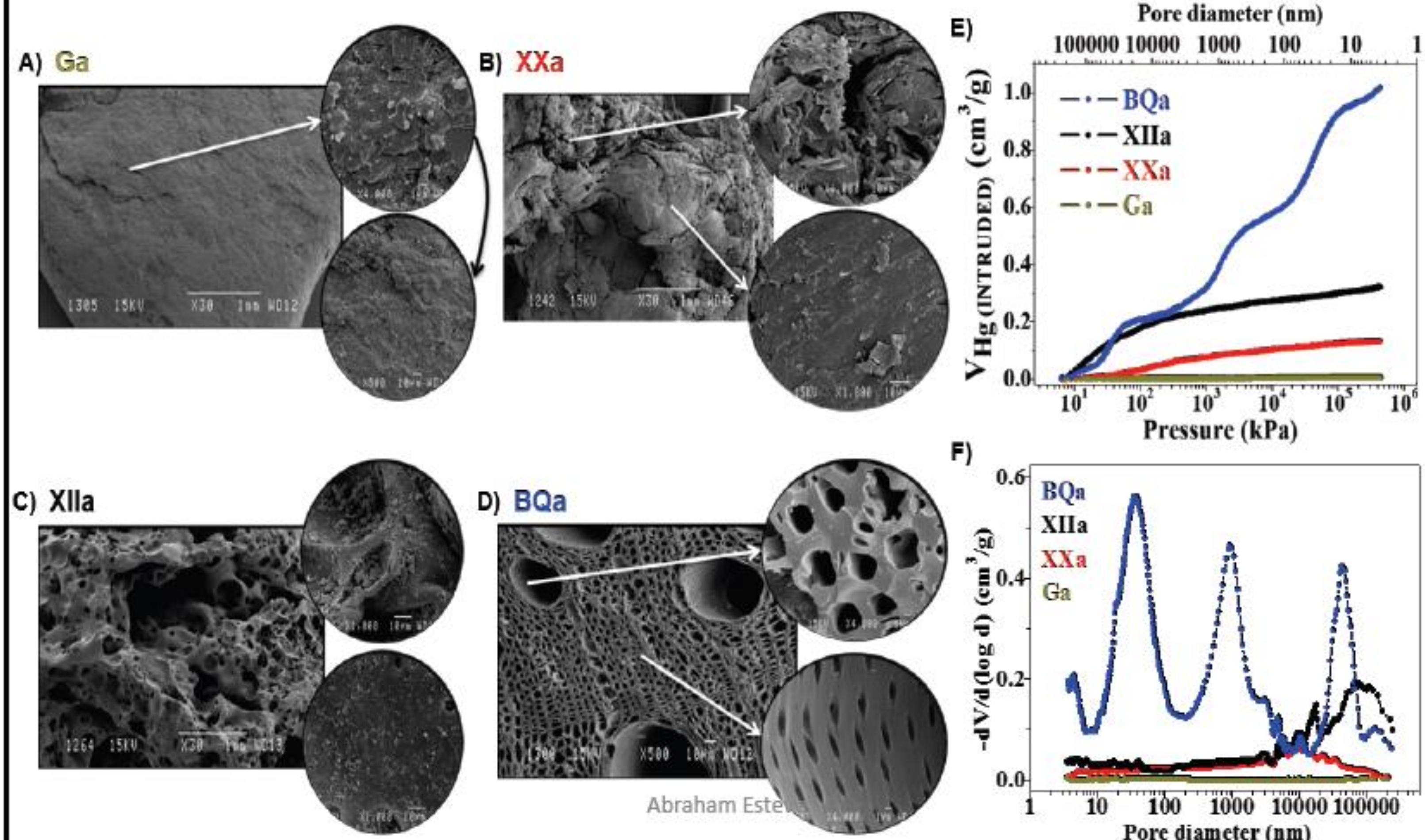


FULFILL LEGAL DISCHARGE REQUIREMENTS AT HRT AS LOW AS 12 HOURS

Aguirre *et al.* 2016

Env.Science: Water Research & Technology

Materials for bed: graphite, coke, EC biochar



Take home messages

- A system with capacity up to 50 p.e. has been operated for two years with results that full-filled the Directive 91/271/EEC for some water reuse applications.
- No energy is consumed. No sludge is produced
- METlands may work under nitrifying conditions
- Enhancing the biodegradation rate by using METlands configurations will lead to reduce the surface requirements of classical CW to ca. 2.5 pe/m^2 or ca. 0.4m^2/pe
- Biodegradation activity can be monitored *in situ* by measuring the electrical current generated by the electroactive bacteria
- Natural material as highly electroconductive biochar can be used as bed

innovation for wastewater treatment

WEBINAR
17/11/2020

Thank you

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