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5th IWA Specialized Conference on Resources-Oriented Sanitation

unesp

Comparative performance between two decentralized wastewater treatment plants in pilot scale for treating low strength wastewater

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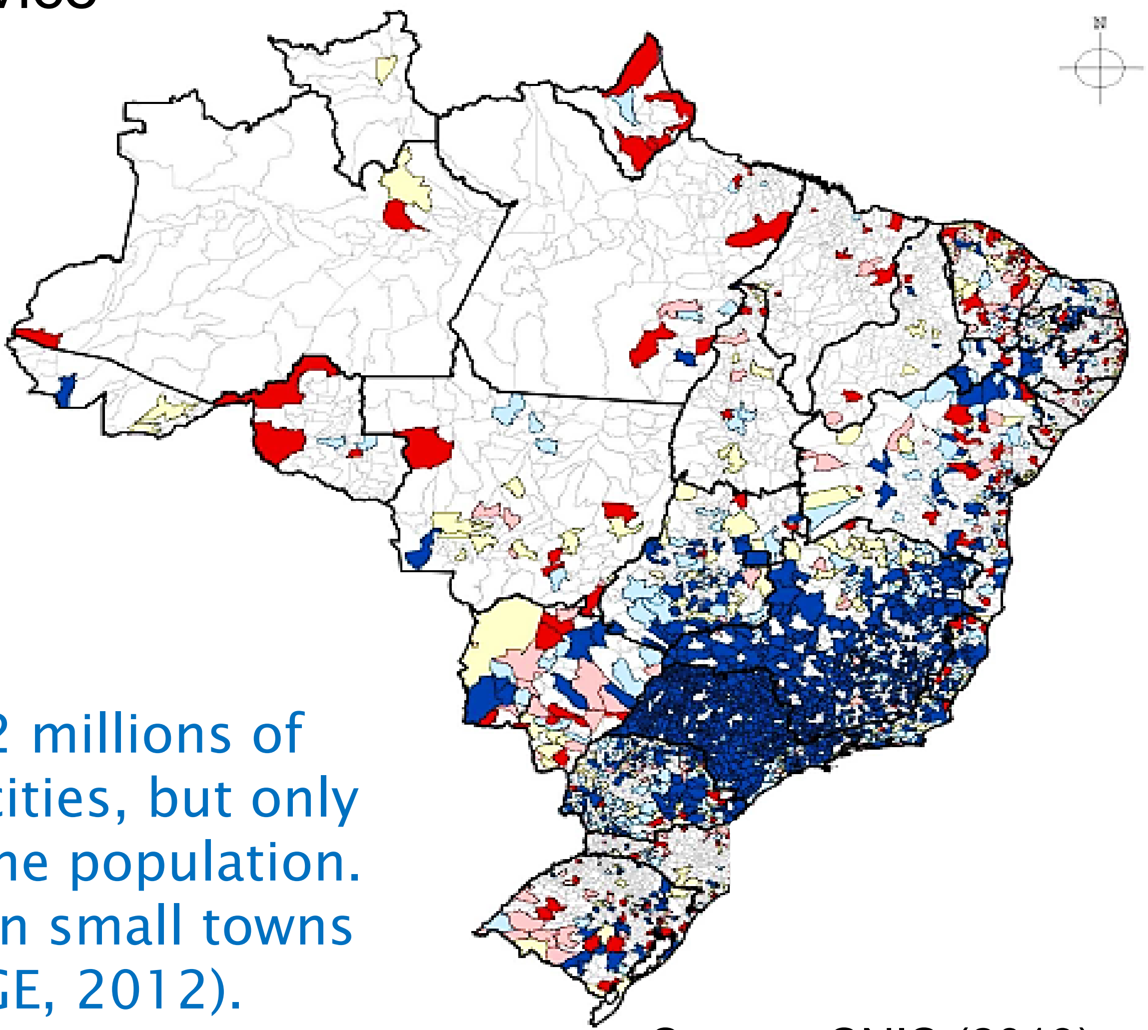
INTRODUCTION

- The situation of sanitation in Brazil is problematic, being demonstrated by the number of cities without any kind of wastewater treatment.

Urban wastewater service indication

- < 10.0% (189 cities)
- 10.0 to 20.0 % (132 cities)
- 20.1 to 40.0% (243 cities)
- 40.1 to 70.0% (352 cities)
- 70.0% (1297 cities)
- No information



Source: SNIS (2013).

0137.575 550 825 1.100 km

Projeção POLICÔNICA
Meridiano Central: -54° W. Gr.

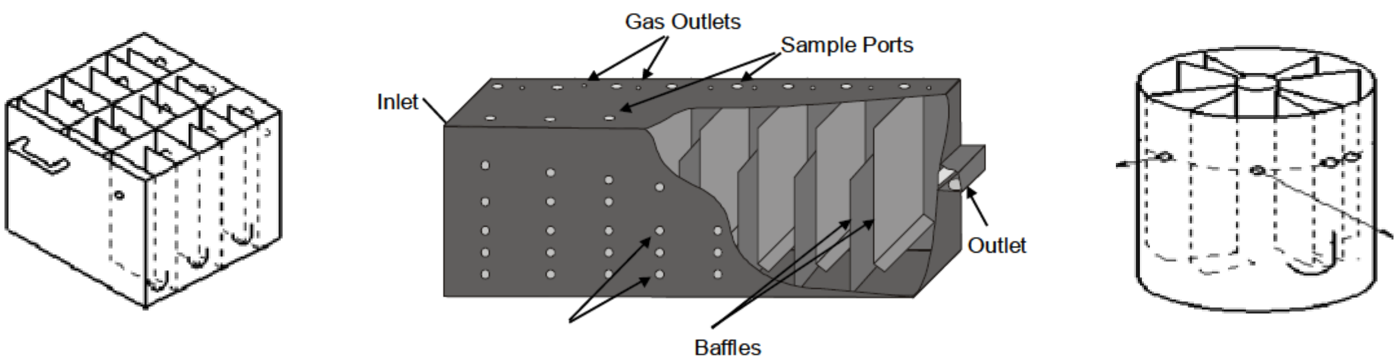
Brazil has around 202 millions of inhabitants and 5,570 cities, but only 200 of it holds half of the population. The rest is distributed in small towns and rural areas (IBGE, 2012).

2685 cities < 10.000 inhab. – 48%
1246 cities < 5000 inhab. – 22%

Decentralized Wastewater Treatment (DEWASTS)

Anaerobic Baffled Reactor (ABR)

- Modification from the conventional UASB, with multiples vertical baffles or chambers, in series and individuals.
- Have different configurations and incorporates the advantages from UASB and phase separation



- In the ABR the liquid flows downward and upward through the chambers

- Gopala Krishna, Kumar & Kumar (2009): 90% for COD in a eight chamber ABR treating low-strength soluble wastewater (COD ≈ 500 $mg.L^{-1}$).

- Bodkhe (2009): 84% of COD removal and 87% of BOD_5 removal, treating municipal wastewater at a HRT of 6 hours.

- Pirsaheb *et al.* (2015) 95% of COD removal, treating baker's yeast wastewater with influent (COD= 15.000 $mg.L^{-1}$).

- Silva *et al*. (in press) 92% of maximum COD removal rate and 78% of the average removal, treating low strength domestic wastewater with four different HRTs.

Constructed wetland (CW)

- High efficiency – pollutant removal, easy operation and maintenance, low cost, good potential for water and nutrient reuse, tolerance to high variability, and function as wildlife habitat.

- CWs may be classified into three groups: free water surface flow, subsurface flow, and hybrid systems (Vyzamal, 2007).

OBJECTIVE

- ✓ To present and compare the results of two decentralized wastewater treatment systems, an Anaerobic/Aerobic Baffled Reactor (AABR) and a Horizontal Subsurface Flow Constructed Wetlands (HSCW) in the treatment of low strength wastewater from an University campus.

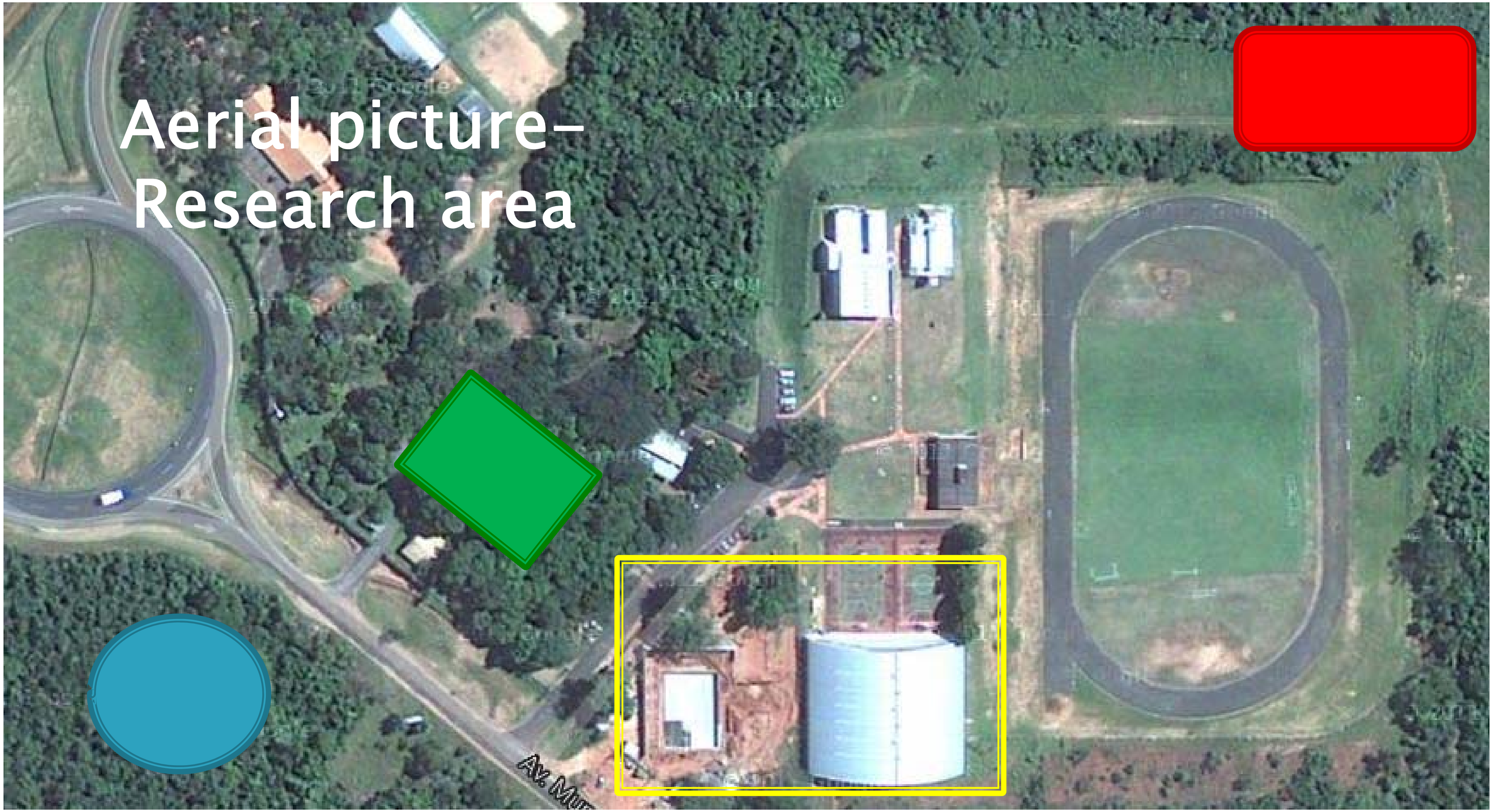
MATERIALS AND METHODS

- Wastewater source
  - ✓ It was used a low strength wastewater collected in UNESP-located in Bauru, Sao Paulo-Brazil, flow of 7.300 $L.d^{-1}$.

Table 1. Minimum, Maximum, Average (A) values and standard deviation (SD) of the inffluent´s features collected at UNESP.

Parameters	Values		
	Minimum	Maximum	A± SD
Temperature (° C)	24	28	25±3
pH	6.8	7.5	7.3 ± 0,2
COD ($mg.L^{-1}$)	105	381	214 ± 63
BOD_5 ($mg.L^{-1}$)	36	162	85 ± 36
TSS ($mg.L^{-1}$)	6	130	43 ± 28
NH_3-N ($mg-N.L^{-1}$)	19	89	40 ± 15
TP ($mg-P.L^{-1}$)	6.4	9.9	8.4 ± 1.5
Organic load ($kgCOD.m^{-3}.d^{-1}$)	0.06	0.61	0.27±0.13

Aerial picture– Research area



Students House

Unesp´s servers association

WWTP

Physical Education Dept.

Schematic diagram of the AABR

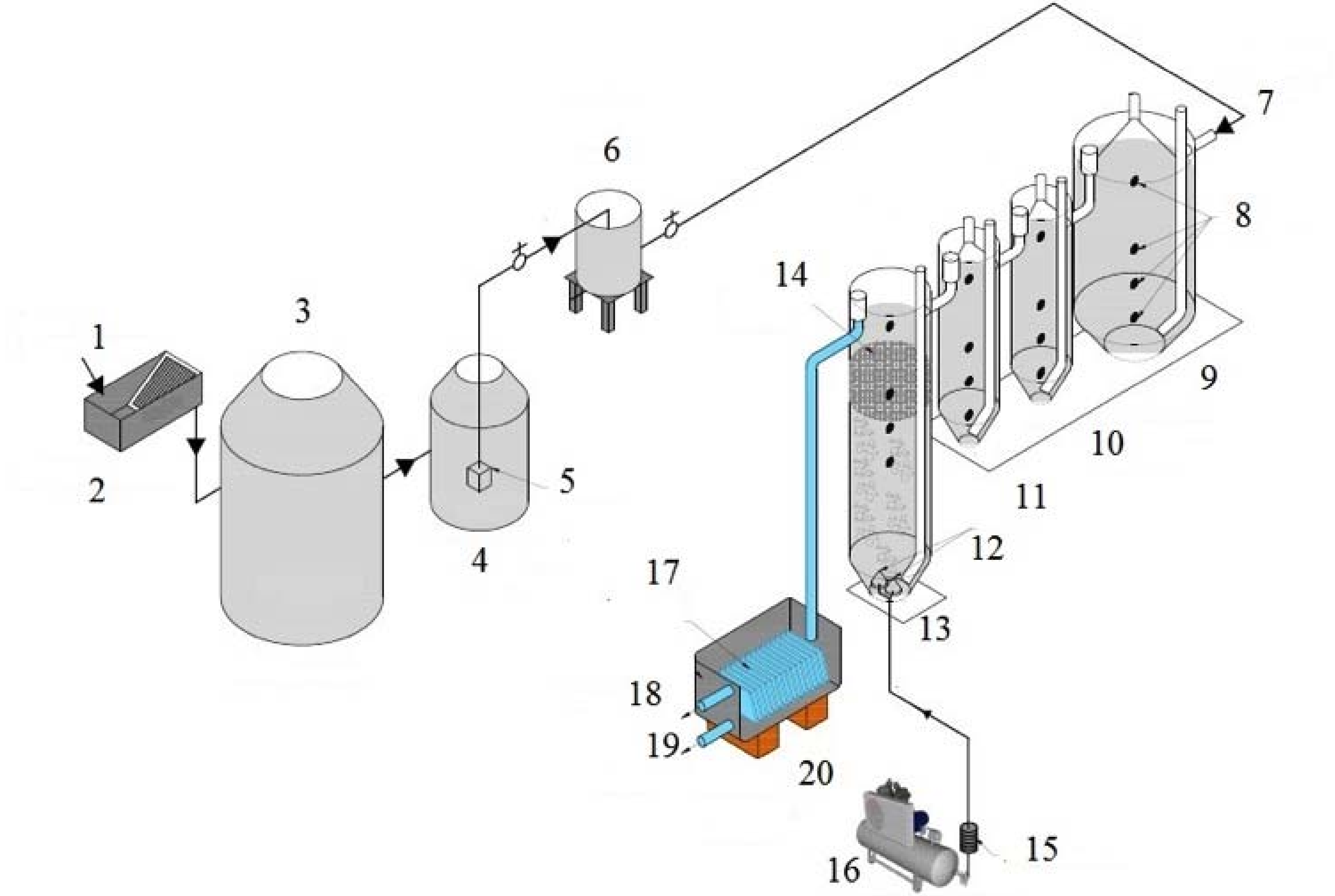


Figure 1. Schematic diagram of the AABR: 1-Wastewater; 2- Screen; 3- Settling tank; 4- Equalization tank; 5- Pump; 6- Storage tank; 7- Influent; 8- Chambers sampling points (for the present study, the higher points were used); 9- Chamber 1; 10-Chamber 2; 11- Chamber 3; 12- Air diffusers; 13- Aerobic chamber; 14- Bamboo rings; 15- Air flow meter; 16- Air compressor; 17-Plastic plates; 18- Effluent; 19-Sludge exit; 20-Laminar settling tank


Entrada
(E)
Câmara 4
(C4)
Câmara 3
(C3)
Câmara 2
(C2)
Câmara 1
(C1)
Saída do
decantador
(SD)

Anaerobic/aerobic Baffled Reactor (AABR)

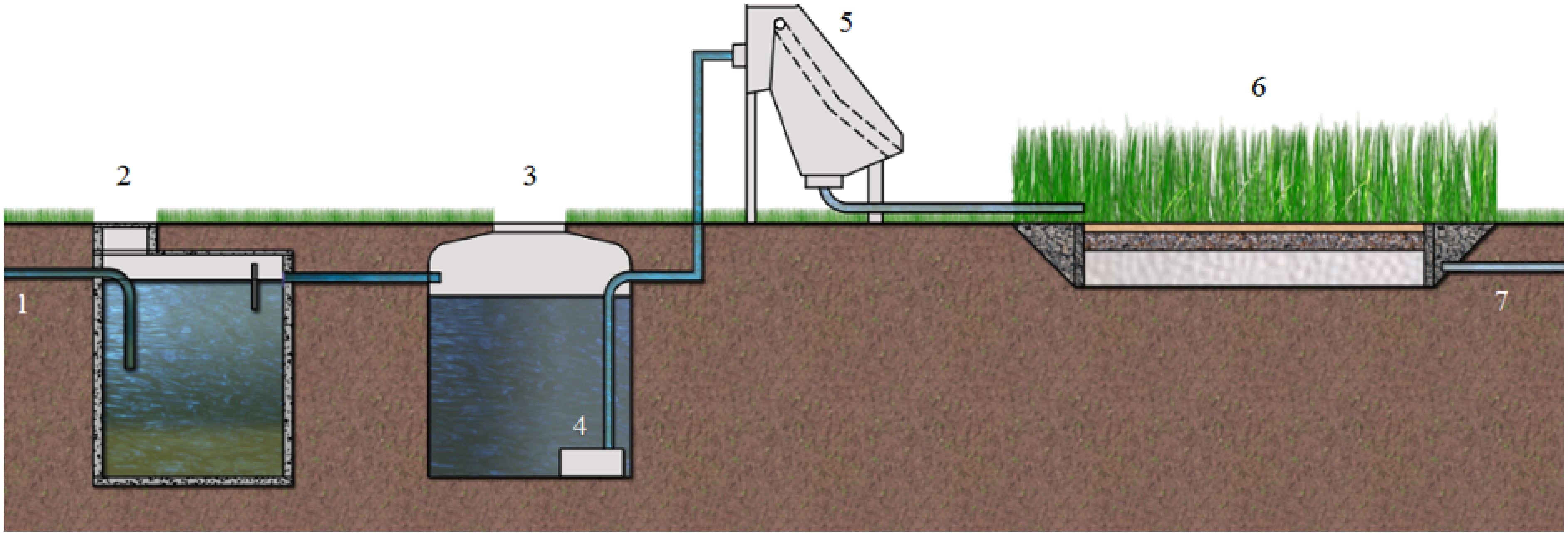
- Four vertical and cylindrical chambers (3 anaerobic and 1 aerobic) and laminar settling tank;
- Total hydraulic volume of 817 L.;
- Area for the construction: 2x3 m;
- Designed to attend: 20 people;
- Operation: 203 days;
- Total Hydraulic Retention Time (anaerobic+aerobic): 33 to 8.25 hours;

WWTP Area

Horizontal Subsurface flow Constructed wetland (HSCW)

- Area of 9.0 x 4.5 m;
- Hydraulic load was 58 $L.m^{-2}.d^{-1}$, operated during 63 days;
- Flow: 2300 $L.d^{-1}$,
- Design to attend 20 people;
- HSCW was filled with sand (layer of 10cm), gravel (layer of 10 cm), styrofoam beads (layer of 40 cm) and crushed rock (layer of 20 cm);
- The plant species used was Vetiver grass (*Chrysopogon zizanioides*)

Schematic diagram of the HSCW



RESULTS AND DISCUSSION

Temperature: Mesophilic range (27° C to 30° C).

pH: 6.8 to 7.5 in the inlet; 6.9 to 7.7 in the AABR's outlet; 6.2 to 6.8 in the HSCW's outlet. (neutral range).

No significant variation in pH and Temperate was observed in both systems, being operated in a optimal range.

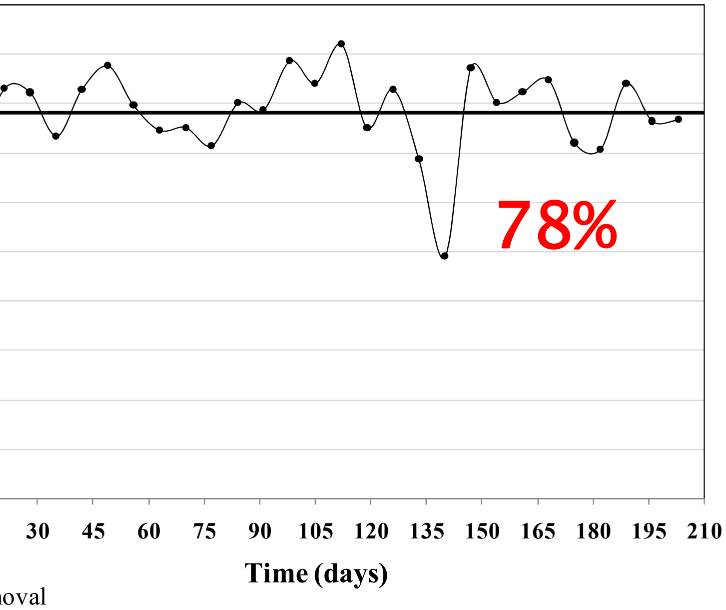
le 1. Average and standard deviation (S.D.) of parameters
centrations studied in the AABR and HSCW

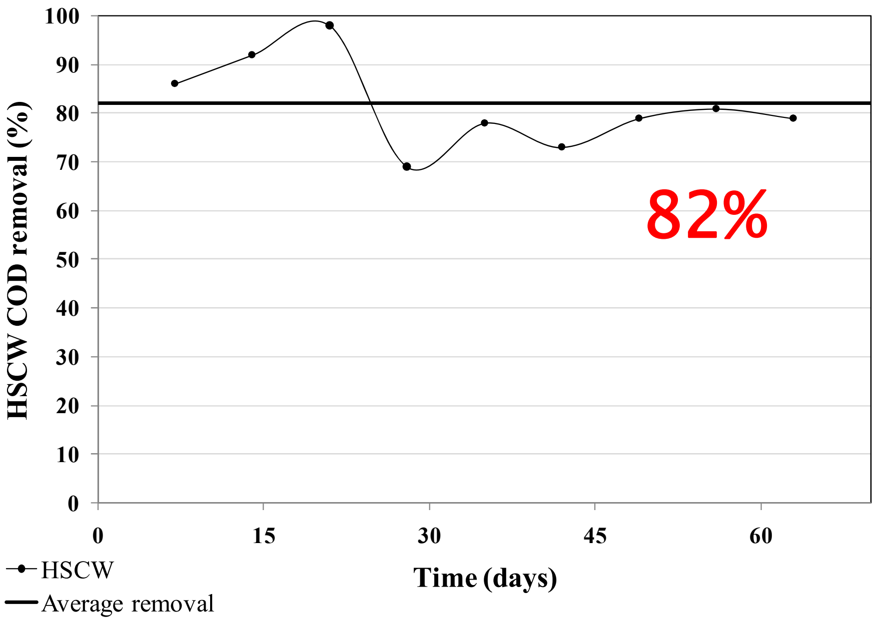
ameters	Units	Inlet*	AABR outlet*	HSCW outlet*
COD	$mgCOD.L^{-1}$	214 ± 63	48 ± 25	47 ± 21
OD_5	$mgBOD_5.L^{-1}$	85 ± 36	23 ± 11	38 ± 11
TSS	$mgTSS.L^{-1}$	43 ± 28	4 ± 3	10 ± 10
H_3-N	$mgN.L^{-1}$	58 ± 18	40 ± 15	52 ± 15
TP	$mgP.L^{-1}$	8.4 ± 1.5	8.3 ± 1.7	7 ± 1.1
pH	---	7.3 ± 0,2	7.3 ± 0,1	6.4 ± 0,18
Coliforms	$MPN.100\ ml^{-1}$	$1.52\ x10^7$	$2.76x10^5$	$1.42x10^6$
E.coli	$MPN.100\ ml^{-1}$	$3.27x10^6$	$1.01x10^5$	$3.45x10^5$

*Average ± standard deviation

Organic matter and suspended solids removal

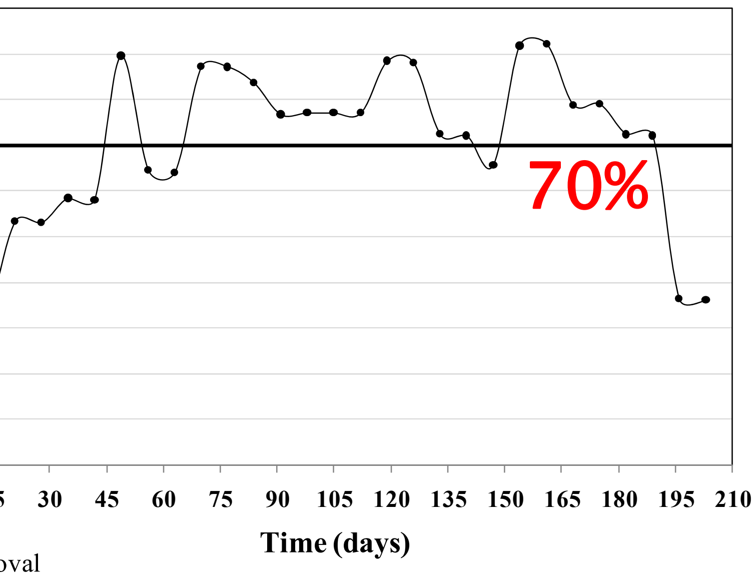
COD

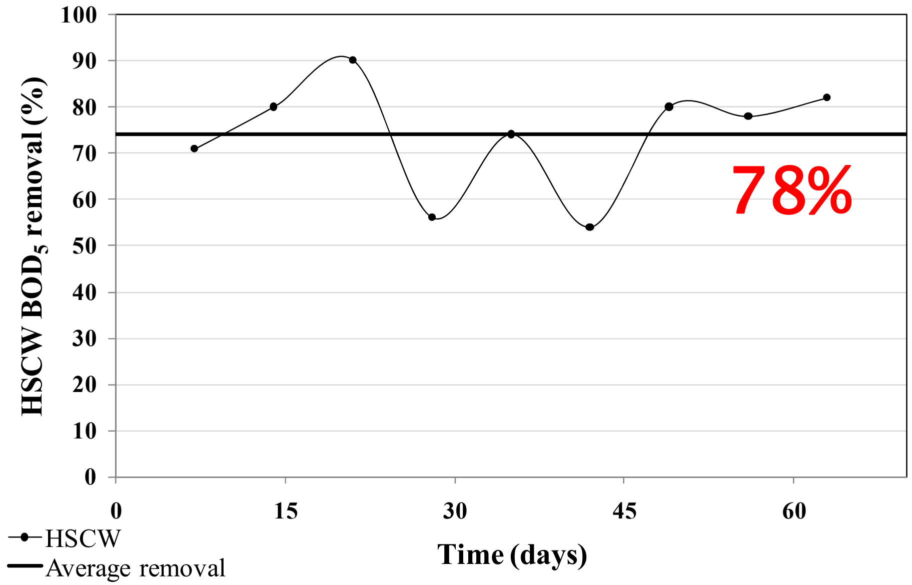




Organic matter and suspended solids removal

BOD_5





Energy cost

Air compressor motor power: <u>1.5 kW, working for 4 hours per day, with a daily power consumption of 6.0 kWh.d^{-1}</u>

Pumps motor power: <u>0.7 kW, working for 2 hours per day, with a consumption of 1.4 kWh.d^{-1}</u>

BR cost per capita: U$ 0.86 per month (20 habitants)

CW cost per capita: U$ 0.16 per month (20 habitants)

he AC chamber was crucial as a polishing step, good removal of COD, but the cost with the air compressor operation could be reduced using ther type of tertiary system, such as the HSCW.

greater need for area

e 2. Approximate consumption values (per capita.day^{-1})
e treatment systems, and of an electric shower.

Equipment	Power (kW)	Habitants	Consumption (kWh/capita.day^{-1})
R (air compressor + pump)	2.2	20	0.30
HSCW (pump)	0.7	20	0.04
Electric shower	3.5	4	0.59

e average daily consumption of power energy, per habitant, of
oth treatment systems was compared with the energy power
nsumption of an electric shower, with a motor power of 3.5kW

eatment capacity per area

ABR used an area of 6.0 m², for 20 bitants, so the total area per capita is 0.25 ².

e HSCW, used an area of 40 m², for 20 bitants, thus the total area per capita is 02 m².

ONCLUSIONS

AABR and HSCW, are promising alternatives in the
tment of low strength domestic wastewater:

AABR – COD : 78 %; BOD : 70%, TSS : 85%

HSCW – COD : 82 %; BOD : 74%, TSS : 83%

e Total Coliforms and *E.coli* removal rates were 2.0 log units for
BR and in the HSCW were 3.0 log and 2.5 log units respectively.

omparing with other publications, both systems
owed good performance in organic matter removal

About the energy power consumption per month by each system

ABR: 180 kWh/month (US$ 0.86 per capita/month)
SCW 42 kWh/month (US$ 0.16 per capita/month)
Cheaper in energy cost

omparing the two systems with a common lectric shower, it was concluded that both ystems spend less energy per month than the lectric shower.

CKNOWLEDGEMENTS

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Pos Graduate Program in
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