Water quality monitoring and hydraulic evaluation of a household roof runoff harvesting system in France

C. Vialle[1,2*], C. Sablayrolles[1,2], M. Lovera[3], M-C. Huau[4], S. Jacob[5] and M. Montrejaud-Vignoles[1,2]

[1] *Université de Toulouse; INP; LCA (Laboratoire de Chimie Agro-Industrielle); ENSIACET, 4 Allées Emile Monso, F-31029 Toulouse, France*

[2] *INRA; LCA (Laboratoire de Chimie Agro-Industrielle), F-31029 Toulouse, France*

[3] *Veolia Water North America, Technical Direction Group, 101, W Washington Street, Suite 1440 East, IN-46204 Indianapolis, USA*

[4] *Veolia Eau, 36-38 avenue Kleber, F-75016 Paris, France*

[5] *Veolia Eau, Direction Technique, Immeuble Giovanni Battista B, 1, rue Giovanni Battista Pirelli, F-94410 Saint Maurice, France*

*Corresponding author: Claire Vialle

(+33) 5 34 32 35 51

(+33) 5 34 32 35 97

claire.vialle@ensiacet.fr

Abstract

The quality of harvested rainwater used for toilet flushing in a private house in the south-west of France was assessed over a one-year period. Twenty-one physicochemical parameters were screened using standard analytical techniques. The microbiological quality of stored roof runoff was also investigated and total flora at 22°C and 36°C, total coliforms, *Escherichia Coli*, enteroccocci, *Cryptospridium* oocysts, *Giardia* cysts, *Legionella species*, *Legionella pneumophila*, *Aeromonas*, and *Pseudomonas aeruginosa* were analysed. Chemical and microbiological parameters fluctuated during the course of the study, with the highest levels of microbiological contamination observed in roof runoffs collected during the summer. Overall, the collected rainwater had a relatively good physicochemical quality but variable, and, did not meet the requirements for drinking water and a microbiological contamination of the water was observed. The water balance of a 4-people standard family rainwater harvesting system was also calculated in this case study. The following parameters were calculated: rainfall, toilets flushing demand, mains water, rainwater used and water saving efficiency. The experimental water saving efficiency was calculated as 87 %. The collection of rainwater from roofs, its storage and subsequent use for toilet flushing can save 42 m^3 of potable water per year for the studied system.

Keywords

Rainwater collection; physicochemical quality; microbiological quality; water saving efficiency; case study; toilet flushing

Introduction

At present, the availability of fresh water resource is one of the major issues the human race is facing. Although many solutions have been proposed, there is much interest in the use of roof-collected rainwater. The process consists in collecting and storing rainwater for the future use, such as toilet flushing, garden watering, etc in order to save valuable drinking water. Thus some recent references in the literature deal with the assessment of the potential for rainwater harvesting (Aladenola and Adeboye, 2010, Zhang et al. 2010).

In Europe, thanks to the EU Water Framework Directive implemented to protect the aquatic environment, certain requirements have been set out involving potential use of Rainwater Harvesting. However, every European country has adopted a different perspective concerning the use of rainwater due to individual interpretations of the word “domestic” used in the European Directive 98/83/CE (European Official Journal 1998).

In France, only external uses (garden watering, cleaning, etc.) were allowed, except in special cases (drought, no mains network). Nevertheless, there were already rainwater harvesting devices on the market, which according to suppliers accounted for 10 000 systems in 2007. Despite reluctance from sanitary authorities (C.S.H.P.F 2006), the increasing demand from private customers leveraged a reconsideration of rainwater harvesting and a new decree authorised and clarified rainwater use inside buildings (French Official Journal 2008). Currently, French law still prohibits the use of harvested rainwater for drinking, showering or bathing, and allows toilet flushing, cleaning ground and, only under conditions, washing clothes. Although this solution appears attractive from an ecological point of view, it is necessary to measure the quality of harvested rainwater due to the potential for health risks as a result of chemical and microbiological contaminants.

Over the last decades, studies in numerous countries including USA, Nigeria, New-Zealand, India, Zambia, Brazil, Canada, Australia, Jordan, New Guinea and South Korea, have investigated the quality of harvested rainwater (Crabtree et al. 1996; Uba and Aghogho 2000; Simmons et al. 2001; Kulshrestha et al. 2003; Handia 2005; May and Prado 2006; Al-Khashman 2009; Despins et al. 2009; Evans et al. 2009; Horak et al. 2010; Lee et al. 2010). In Europe, rainwater quality assessment was studied by Förster 1999; Albrechtsen 2002; Polkowska et al. 2002; Fewtrell and Kay 2007; Melidis et al. 2007; Oesterholt et al. 2007; Sazakli et al. 2007; Schriewer et al. 2008; Tsakovski et al. 2010. Although a number of studies have found collected rainwater to be non-potable, showing unacceptable levels of microbiological contamination and poor physicochemical qualities, “a clear consensus on the quality and health risk associated with roof-collected rain-water has not been reached” (Evans et al. 2006). Other studies focused on hydrological or economic data for rainwater harvesting (Chilton et al. 1999; Fewkes 1999a; Herrmann and Schmida 1999; Villarreal and Dixon 2005, Khastagir and Jayasuriya 2011). This literature review draws attention to the need for Research and Development on the hygienic and hydrological aspects of rainwater harvesting.

Thus, the present case study has been carried out over a year using a commercially available rainwater collection system, installed in south-west of France. The objectives were firstly to monitor the water from the tank and the water delivered for uses, in order to provide scientific data on physicochemical and microbiological quality and secondly, to collect data on hydraulic aspects linked to roof-runoff harvesting.

Methods

Sampling site

A commercially available domestic rainwater collection system (Sotralentz Habitat) was installed in a rural village in south-western France. The house was occupied by a family consisting of two parents and two children. The average rainfall in this region is 760 mm, and the average daily temperatures range from 7.9 - 18.3 °C. In the system installed, rainwater is first collected from a 204 m^2 surface area of tiled roof. This water is then channelled via open zinc gutters and down pipes to a wire filter with a mesh before entering into an underground, 5 m^3 capacity PEHD storage tank, through a calm inlet. In the event of an overflow, excess water is fed into a nearby canal. A submerged intake with an inlet filter attached to a float is used to pump water inside the house. Prior to use, collected rainwater is treated by being passed through a physical filter and an activated carbon filter. When insufficient water is available in the tank, a probe activates a valve to allow pumping from a backup drinking water tank. Rainwater collected is available to flush two 9-L flush WCs. A schematic of the rainwater collection system is shown in Figure 1.

The device also includes a rain gauge with tipping bucket and a pressure transducer to measure water tank level. A triangular weir and a flow meter were used to measure the volume evacuated via the overflow. Water meters were installed to measure the total volume delivered to the toilet flushing system and the quantity of mains water supplied.

In order to monitor quality water, water samples were collected weekly from the tank (Figure 1, point 1) and from the outside tap (Figure 1, point 2). Concerning point 1, grab samples were taken from the surface of the tank using a sampling rod and beaker, the latter having previously been disinfected with ethanol and rinsed with UHQ water once and with tank water twice. Concerning point 2, samples were taken after water had been run to waste for at least one minute and after disinfection of the tap with ethanol. All samples were placed in polyethylene bottles for chemical analysis or individual sterile bottles for microbiological analysis, and transported to the laboratory in a chilled cold-box. Temperatures of the samples were measured *in situ* before transfer. Samples were stored at 4°C and assessed within 24h for microbiological analysis or frozen to await chemical analysis.

Analytical determinations

Samples were analyzed for pH and conductivity. Standard solutions CertiPUR (VWR) at 4.01 and 7.00 at 25°C and a standard solution of KCl at 0.01 $mol.L^{-1}$ i.e. 1 413 $\mu S.cm^{-1}$ at 25°C were respectively used to check the calibration. Samples were also analyzed for colour, turbidity, total hardness, simple alkalimetric title and complete alkalimetric title, total organic carbon, chemical oxygen demand, biological oxygen demand, total nitrogen, and total phosphorus.

Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, Mg^{2+}, Ca^{2+}, Na^+, K^+, NH_4^+ were analyzed with ion chromatography with a limit of quantification 0.1 $mg.L^{-1}$. Devices used are presented in Table 1.

Concerning microbiological quality, samples were examined using the relevant ISO standards: ISO 6222 for total flora at 22°C and 36°C, ISO 9308-1 for total coliforms and *Escherichia coli*, ISO 7899-2 for enterococci, NF T 90-431 for

*Legionella sp*ecies and *Legionella pneumophilia,* NF T 90-455 for *Cryptosporidium* oocysts and *Giardia* cysts, and ISO 16266 for *Pseudomonas aeruginosa.* Finally*, Aeromonas* were identified after filtration.

Results and discussion

Roof runoff water quality

The minimum, maximum, average and median values of classical parameters for rainwater collected in the tank were used to compare the measured variables with French drinking water guidelines (French Official Journal 2007) (Table 2). The pH range of collected water was 5.6 - 10.4. Extreme alkaline values were observed after strong weather events. For example, the highest pH of 10.4 was recorded after a violent storm and remained elevated for five weeks before returning to a slightly acidic condition. Outside of these weather-related spikes, the pH range was 5.6 - 6.9. By comparison, the literature for Europe has reported the following pH ranges for runoff water: 6.0 - 8.2 (Villarreal and Dixon 2005), 7.6 – 8.8 (Sazakli et al. 2007) and 5.8 - 8.4 (Schriewer et al. 2008). Half of the samples collected in this study exceed the drinking water limits for colour (15 mg Pt/L) and turbidity (2 NTU). Ion concentrations were low, with 89 % of conductivity values being below 100 $\mu S.cm^{-1}$. This finding indicates that harvested rainwater had a low level of mineralization. Concentrations in ion comply with the drinking water guidelines available, except for ammonia, which was often detected at unacceptably high levels. Harvested rainwater has a relatively good physicochemical quality but variable and does not meet drinking water standards.

The microbiological composition of the tank water varied over the course of the year (Figure 2). Total flora is a measure of the total bacterial load. At 22 °C, bacterial counts ranged from 10 to $6.32x10^5$ organisms/mL. Almost all samples showed presence of coliform bacteria. Two faecal indicators were also monitored and showed varying degrees of contamination. Roof-collected rainwater often showed high levels of contamination with enterococci: the maximum value exceeded 10,000 CFU/100 mL. The majority of samples tested were positive for *E. coli* (79 %, n= 53). In fact, *E. coli* and enterococci were simultaneously present in samples, always with enterococci having the higher concentrations. Although these bacteria are unable to reproduce in water, enterococci has a better survival ability in water than *E. coli*. Other parameters were checked monthly. The pathogen *Legionella pneumophila* was quantified once in the tank (700 CFU/L). Concerning parasites, one was positive among 14 investigations: one cysts of *Giardia* for 20 L i.e. 0.0050 n/100mL was quantified. Half of samples investigated were contaminated in *Aeromonas* (43 %, n=28) and *Pseudomonas aeruginosa (*41 %, n=17). Microbiological results of roof runoff quality are congruent with a number of other studies indicating that roof-collected rainwater makes poor quality drinking water due to high levels of bacterial contamination (Sazakli et al. 2007; Albrechtsen 2002; Nolde 2007; Simmons et al. 2001; Blangis and Legube 2007). In fact, the microbiological results show a regular variability and a degraded quality not consistent with the bathing waters quality European standards.

Results for samples from the tap were similar except when the system was working with a supply of drinking water: mains water has a pH of about 7.5 and higher values of conductivity, hardness, and alkalinity. These parameters could be used as switching indicators to show when the system is not working with rainwater because of a lack of water in the tank. Using harvested rainwater introduce a variable level of micro-organisms into the household. This is consistent with recommendation to equip with a disinfection the harvesting rainwater system, regarding to the potential sanitary risks and uses into the household.

Nevertheless, it must be highlighted that no first-flush diversion was used in this study. Now such a system could permit to decrease concentrations of some of the tested water quality parameters (Mendez et al. 2011).

Roof runoff water quantity

A rainwater collection system of a 4-people household with a 5 m^3 tank was monitored over a twelve-month period. This period corresponds to a rainfall of about 766 mm distributed among 174 days and 40 % of these rainy days presented precipitations inferior to 2 mm. In this study, the daily WC flushing demand varies between 0 L and 309 L for the household with an annual average of 120 L, which corresponds to 30 L i.e. 3.3 flushes per day per inhabitant. This value is approximately 20 % of the average per person domestic water consumption (137 L per day) in France (C.I.Eau 2010). The family, in this case study, was also a representative of a French household. Mains water supply was used for 53 days over the entire study period: 15 days in March-April, 5 days in July and 33 days from mid-August to the end of September.

Some experience feedback can be reported. To begin, the WC usage in the test house was higher than expected in July due to a faulty ballcock, which resulted in the loss of almost 3 m^3 of water in one day. Then, the wire filter at the entrance of the tank is automatically rinsed once a week in the rainwater harvesting system studied. Frequency of cleaning is independent of the weather. Thus, when a rain occurs just after the cleaning, a partial clogging can occur that will remain till the next week. Indeed some overflows were registered, even when the tank was not full. In term of maintenance and operation, the clogging of the filter at the entrance of the tank can affect the overall efficiency of the collection system which highlights the importance of correct and regular maintenance of rainwater harvesting systems. To finish, when the mains water supply was used, 1 150 L of stored runoff remained in the tank, which corresponds to 20 % of the 5 000 L. In term of design and operation, it is important to distinguish the available storage volume of the tank from the commercial volume of the tank, which must be higher. The dead volume of the tank cannot indeed be neglected, when the mains water supply is used and must be taken into account for the sizing and design.

The water saving efficiency (WSE) is a measure of how much mains water has been conserved in comparison to the overall demand of the WC and is also given by dividing the used rainwater volume by the WC demand volume. The results of the 12-month period are given in Table 3. WSE ranges from 52 % in September to 100 %. A similar study in the UK was realised with a storage tank of 2.032 m^3 and a house occupancy varying between three and five people. A monthly WSE ranging from 4 % to 100 % was obtained (Fewkes 1999b). Our study showed that 48 m^3 of water was used for toilet flushing over the whole study period, of which 6 m^3 was supplied from the mains network. As a result, 42 m^3 of potable water was saved. The corresponding WSE of the system was 87 % for the toilet flushing.

Concluding remarks

In the present work, the performance of a rainwater collection system was monitored over a period of one year. Conclusions or feedback experience may be drawn from this case study. On one hand, chemical and microbiological parameters fluctuated during the course of the study, with the highest levels of microbiological contamination observed in roof runoffs collected during the summer. Whereas roof-collected rainwater, in general, meets the classical parameters for drinking water in terms of physical chemistry, the bacterial contamination in the collected samples was above acceptable limits. In concordance with previous studies, our results show that roof rainwater runoff is not suitable for human consumption due to the high levels of microbiological contamination within it. On the other hand, rainwater collection systems can reduce the potable water consumption. An average saving of 42 m^3 of water per year was determined for a 4-people standard family.

To conclude, this study provide useful information about quality and push to pay attention for uses into a household (such as toilet flushing, cleaning ground, etc), according to the variability of rainwater quality and its poor microbiological quality, frequently under the bathing waters quality standards. It is key to think the design and operation of harvesting rainwater system into the combine parameters use/quality/treatment.

Aknowledgement

The authors would like to thank Sotralentz Habitat for their provision of rainwater-harvesting equipment and Laurent Monier (Veolia Eau, Saint-Maurice, France) for his technical support.

References

Aladenola O, Adeboye O (2010) Assessing the potential or rainwater harvesting. Water Resour Manage 24 (10): 2129-2137

Al-Khashman OA (2009) Chemical characteristics of rainwater collected at a western site of Jordan. Atmos Res 91 (1):53-61

Albrechtsen HJ (2002) Microbiological investigations of rainwater and graywater collected for toilet flushing. Water Sci Technol 46 (6-7):311-316

Blangis D, Legube B (2007) Treatment of rain water by solar photocatalysis. Eur J Water Qual 38 (2):121-130

Chilton JC, Maidment GG, Marriott D, Francis A, Tobias G (1999) Case study of a rainwater recovery system in a commercial building with a large roof. Urban Water 1:345-354

Crabtree KD, Ruskin RH, Shaw SB, Rose JB (1996) The detection of cryptosporidium oocysts and Giardia cysts in cistern water in the U.S. Virgin Islands. Water Res 30 (1):208-216

Despins C, Farahbakhsh K, Leidl C (2009) Assessment of rainwater quality from rainwater harvesting systems in Ontario, Canada. J Water Supply Res Technol - Aqua 58 (2):117-134

Evans CA, Coombes PJ, Dunstan RH (2006) Wind, rain and bacteria: the effect of weather on the microbial composition of roof-harvested rainwater. Water Res 40 (1):37-44

Evans CA, Coombes PJ, Dunstan RH, Harrison T (2009) Extensive bacterial diversity indicates the potential operation of a dynamic micro-ecology within domestic rainwater storage systems. Sci Total Environ 407 (19):5206-5215

Fewkes A (1999a) Modelling the performance ofrainwater collection systems: towards a generalised approach. Urban Water 1:323-333

Fewkes A (1999b) The use of rainwater for WC flushing: the field testing of a collection system. Build Environ 34:765-772

Fewtrell L, Kay D (2007) Microbial quality of rainwater supplies in developed countries: a review. Urban Water J 4 (4):253-260

Förster J (1999) Variability of roof runoff quality. Water Sci Technol 39 (5):137-144

Handia L (2005) Comparative study of rainwater quality in urban Zambia. J Water Supply Res Technol - Aqua 54 (1):55-64

Herrmann T, Schmida U (1999) Rainwater utilisation in Germany: efficiency, dimensioning, hydraulic and environmental aspects. Urban Water 1:307-316

Horak HM, Chynoweth JS, Myers WP, Davis J, Fendorf S, Boehm AB (2010) Microbial and metal water quality in rain catchments compared with traditional drinking water sources in the East Sepik Province, Papua New Guinea. J Water Health 8 (1):126-138

Khastagir A, Jayasuriya N. (2011) Investment evaluation of rainwater tanks. Water Resour Manage 25 (14): 3769-3784

Kulshrestha UC, Kulshrestha MJ, Sekar R, Sastry GSR, Vairamani M (2003) Chemical characteristics of rainwater at an urban site of south-central India. Atmos Environ 37 (21):3019-3026

Lee JY, Yang JS, Han M, Choi J (2010) Comparison of the microbiological and chemical characterization of harvested rainwater and reservoir water as alternative water resources. Sci Total Environ 408 (4):896-905

May S, Prado RTA (2006) Experimental evaluation of rainwater quality for non-potable applications in the city of Sao Paulo, Brazil. Urban Water J 3 (3):145-151

Melidis P, Akratos CS, Tsihrintzis VA, Trikilidou E (2007) Characterization of rain and roof drainage water quality in Xanthi, Greece. Environ Monit Assess 127 (1-3):15-27

Mendez CB, Klenzendorf JB, Afshar BR, Simmons MT, Barrett ME, Kinney KA, Kirisits MJ (2011) The effect of roofing material on the quality of harvested rainwater. Water Res 45 (5):2049-2059

Nolde E (2007) Possibilities of rainwater utilisation in densely populated areas including precipitation runoffs from traffic surfaces. Desalination 215 (1-3):1-11

Oesterholt F, Martijnse G, Medema G, van der Kooij D (2007) Health risk assessment of non-potable domestic water supplies in the Netherlands. J Water Supply Res Technol - Aqua 56 (3):171-179

Polkowska Z, Gorecki T, Namiesnik J (2002) Quality of roof runoff waters from an urban region (Gdansk, Poland). Chemosphere 49 (10):1275-1283

Sazakli E, Alexopoulos A, Leotsinidis M (2007) Rainwater harvesting, quality assessment and utilization in Kefalonia Island, Greece. Water Res 41 (9):2039-2047

Schriewer A, Horn H, Helmreich B (2008) Time focused measurements of roof runoff quality. Corros Sci 50 (2):384-391

Simmons G, Hope V, Lewis G, Whitmore J, Gao W (2001) Contamination of potable roof-collected rainwater in Auckland, New Zealand. Water Res 35 (6):1518-1524

Tsakovski S, Tobiszewski M, Simeonov V, Polkowska Z, Namiesnik J (2010) Chemical composition of water from roofs in Gdansk, Poland. Environ Pollut 158 (1):84-91

Uba BN, Aghogho O (2000) Rainwater quality from different roof catchments in the Port Harcourt district, rivers state, Nigeria. J Water Supply Res Technol - Aqua 49 (5):281-288

Villarreal EL, Dixon A (2005) Analysis of a rainwater collection system for domestic water supply in Ringdansen, Norrköping, Sweden. Build Environ 40:1174-1184

Zhang Y, Grant A, Sharma A, Chen D, Chen L (2010) Alternative water resources for rural residential development in western Australia. Water Resour Manage 24(1):25-36

Fig. 1 Schematic of the rainwater harvesting system installed in south-western France

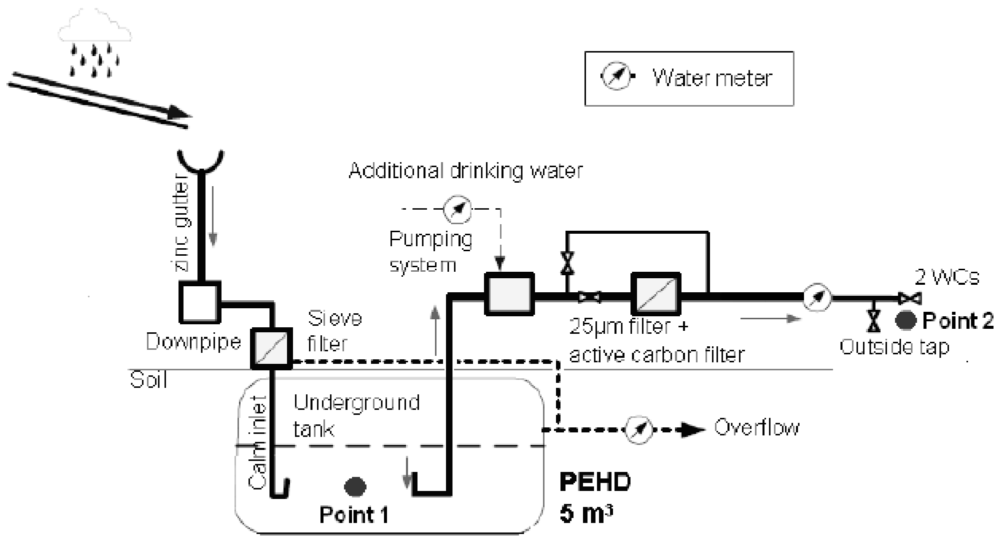

Fig. 2 Box plots of the microbiological parameters concentrations (Sampling point 1)

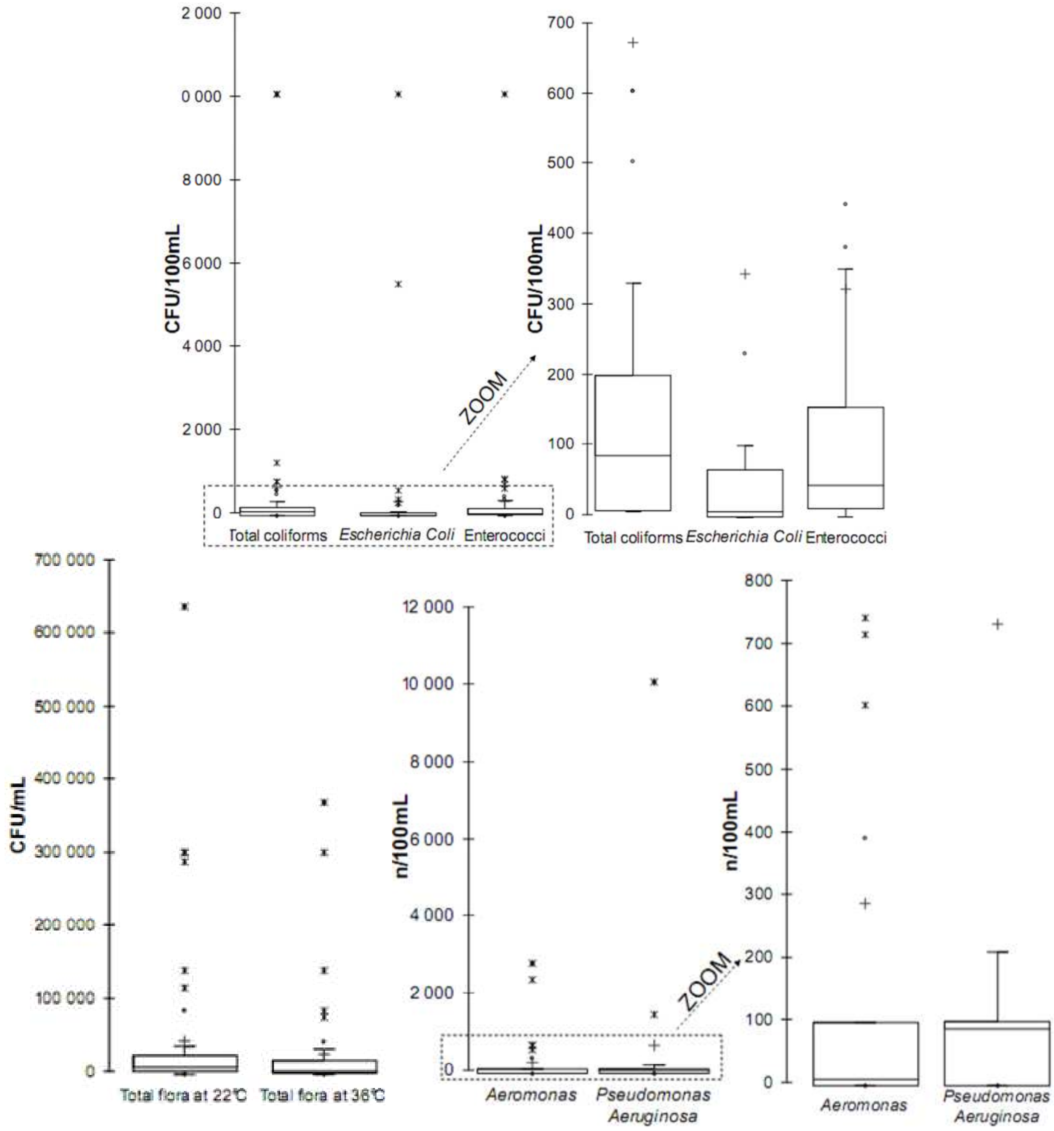

Table1 Physical chemistry parameters analyzed

Parameter	Device	Parameter	Device
pH	pH330 – SenTix 41 - WTW	Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}	AG/AS 18 - ICS 2000 - Dionex
Conductivity	330i – Tetracon 325 - WTW	Mg^{2+}, Ca^{2+}, Na^+, K^+, NH_4^+	CG/CS 12 - ICS 3000 - Dionex
Colour	Nessleriser 1209 - Lovibond	Total organic carbon (TOC)	COT meter - Shimadzu
Turbidity	2100P - Hach	Total nitrogen (Tot-N)	Spectroquant - Merck
Total hardness	Calculus (Mg^{2+}, Ca^{2+})	Total phosphorus (Tot-P)	Spectroquant - Merck
Simple Alkalimetric Title (AT)	Titrimetry	Chemical oxygen demand (COD)	Spectroquant - Merck
Complete Alkalimetric Title (CAT)	Titrimetry	Biological oxygen demand (BOD)	Oxytop - WTW

Table 2 Descriptive statistics for the dataset (Sampling point 1)

Variables	Units	N	Min	Max	Mean	Median	French Drinking Water Guidelines
pH	-	55	5.6	10.4	6.5	6.2	6.5 to 9
Conductivity	$\mu S.cm^{-1}$	55	13.5	235.0	56.2	38.2	180 to 1 000 (20°C)
Colour	$mg\ Pt.L^{-1}$	55	<5	39	18	19	15
Turbidity	NTU	53	0.50	6.1	2.4	2.0	2
hardness	$mmol.L^{-1}$	55	<0.01	0.58	0.16	0.11	
AT	$mmol.L^{-1}$	55	<0.20	0.9	0.10	<0.20	
CAT	$mmol.L^{-1}$	55	<0.40	1.1	0.30	0.30	
Cl^-	$mg.L^{-1}$	54	0.55	4.0	1.9	1.7	250
SO_4^{2-}	$mg.L^{-1}$	54	0.50	6.6	1.9	1.8	250
NO_3^-	$mg.L^{-1}$	54	0.54	7.8	2.8	2.4	50
PO_4^{3-}	$mg.L^{-1}$	54	<0.10	0.54	0.17	0.19	
Mg^{2+}	$mg.L^{-1}$	54	<0.10	0.71	0.27	0.24	
Ca^{2+}	$mg.L^{-1}$	54	1.0	19	4.4	2.9	
Na^+	$mg.L^{-1}$	54	0.30	2.9	1.1	0.93	200
K^+	$mg.L^{-1}$	54	0.15	4.9	1.2	0.78	
NH_4^+	$mg.L^{-1}$	54	<0.10	1.7	0.58	0.32	0.1
TOC	$mg.L^{-1}$	55	0.50	5.1	2.3	2.2	2
COD	$mgO_2.L^{-1}$	11	<30	34	<30	<30	
BOD_5	$mgO_2.L^{-1}$	16	<3	17	<3	<3	
Tot-N	$mg.L^{-1}$	12	<1	8,0	1,7	<1	
Tot-P	$mg.L^{-1}$	11	<0.1	0.2	<0.1	<0.1	

Table 3 Water saving efficiency of the rainwater system for March 2009-February 2010

Month	Rainfall (mm)	WC demand (L)	Mains water (L)	Rainwater used (L)	Water saving efficiency (%)
March	30	4 114	1 041	3 073	75
April	185	4 164	629	3 535	85
May	12	3 577	0	3 577	100
June	47	3 001	0	3 001	100
July	29	6 827	1 225	5 602	82
August	48	3 790	1 667	2 123	56
September	26	3 218	1 560	1 658	52
October	50	3 602	0	3 602	100
November	126	3 705	0	3 705	100
December	84	4 142	0	4 142	100
January	64	4 264	0	4 264	100
February	67	3 835	0	3 835	100
Minimum	12	3 001	0	1 658	52
Maximum	185	6 827	1 667	5 602	100
Totals	**766**	**48 239**	**6 122**	**42 117**	**87**