International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Contribution to the Study of the Problem of the Management of the Network of Distribution of Water Processed by Plants Tshopo and Burned in the Kisangani Region (DR Congo)

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Abstarct: ***This study is to assess the possibility of alteration of the quality of treated water output of the Tshopo plants through the faucets of users taking into account the age of low pressure (LP) and high pressure (HP) network and due to hydraulic residence time population growth estimated at 294,37 percent, the lack of sanitation facilities and excessive so no recycled human waste production as weather conditions. The age of the LP, especially after very heavy frequent rains year-round in the Equatorial area, affect the quality of treated water between the output of factories and the taps of the users. In chemical terms, 2 samples processed on 170 gave color and turbidity slightly higher than national standards with peak maxima days of intense rainfall. On a microbiological level, fecal streptococci (SF) appear to be resistant to disinfection than fecal coliform (FC). Medians of most probable number (MPN) per 100 ml of the SF went from 28 to 30 falling to 7 then back to 19 to the BP (old network) and from 28 to 14 in 17 at HP (nine network). Those of the FC zero out of factories (0P2), on a few taps of the BP (3P3, 4P7, 4P11 and 4 P12) and all the taps in the HP. The rest of the taps, following a heavy rain or a healthy environment, gave values greater than the standard DR Congo (0/100 ml). Hence the need to establish good human waste management and good environmental sanitation policy and also adaptation, days of intense rainfall, the treatment changes in various parameters of first aid in order to improve the quality of water to produce, according to the World Health Organization (WHO) guidelines and standards, DR Congo.***

Keywords: equatorial climate, low pressure, high pressure, disinfection, environment

1. Introduction

Water «that's life» when she has impeccable quality for is not becoming « the death ». Faced with this situation, plants capture, treatment and distribution of water for human consumption must develop appropriate systems to protect consumers from their service. [1], [2], [3].

From 1993 to 2015, estimated population of Kisangani has experienced a population growth of 294,37%, multiply the uses of water and the production of anthropogenic waste are intensifying at a time where the sanitation infrastructure disappear. Raw and treated water resources are under pressure and their qualities are degraded and born of concerns which are at the origin of the controversy between the qualities of bottled waters, groundwater and water from the tap [4], [5],[6].

The distribution system of drinking water in the region of Kisangani are continually exposed to a stream of biodegradable organic matter and microorganisms from anthropogenic waste treatment plant, but also leaks, flights of water and unsanitary environment around the faucet of creation [7].

Water-related diseases are due to the lack of drinking water, floods usually as a result of the torrential rains or the tidal waves caused by earthquakes or volcanic eruptions underwater as the tsunami of 26/12/2004. The nature and content of the organic or inorganic compounds as well as aquatic organisms that contains a water source characterizes. Should be integrated in the management of water resources in Kisangani taken into account of the road vibrations by heavy gear, conflicting uses (bathing, irrigation, industries, shellfish aquaculture, fish farming, livestock..) without forgotten take into account the impact of rainwater on the environment [8], [9], [10].

The water's interaction with all human activities and ecosystems and its pollution poses particular health risks both to plants and animals to humans. Apart from the dumping of human waste in streams, rivers, air... the fertilizers and pesticides used in agriculture and green spaces of leisure or gardening will eventually seep into the supply network in water and pollute her. Therefore, there is increasing risk of pollution, said "fecal peril" of treated

water distributed to the contact with the unsanitary environment [11], [12] [13].

The purpose of the treatment and distribution of drinking water is not to send a sterile water to the taps of consumers but water not presenting any risk from the point of view of public health [7].In case there would be changes in the quality of water networks, who would return the responsibility?

2. Methodologies

2.1. Middle and working material

Kisangani, formerly called Stanleyville, is chief town of the Province of the Tshopo (0°31 'N, 25° 11'E, 428 m). In the Kisangani region, the climate is equatorial of the Afi type (hot, wet and very low thermal amplitude) and rainfall are abundant but irregularly distributed with average maxima of 1915,4 mm (March to May) and September in November and average minimum 1.417,5 mm (from December to February) and from June to August [4], [14]

Our material is water treated and distributed by TSHOPO I & II plants in the region of Kisangani (RD Congo).

2.2. Sampling

180 samples, taken between 7 to 10 h00', on 18 sites including the capture of raw water of the Tshopo river (0P1) and the output taps of users (XPi where X = distance (in Km) from the output of factories and plants Tshopo (0P2) P = point of sampling and i = the debit order). Analyzed 18parameters per sample including 2 bacteriological.

2.3. Analysis

2.3.1. Physicochemical analysis

To determine the physicochemical quality of the analyzed waters the following parameters were measured in the laboratory according to the procedures described by HACH, REGIDESO (DR Congo water board) and RODIER J. (2009): color, turbidity, NO_2^-(nitrite ions), NO_3^- (nitrate ions), oxidizable materials (MO), the quantity of suspended solids (QSS) per literof water, *p*H and chlorine-free (Cl_2-free) [15], [16], [13].

2.3.2. Microbiological analyses

Determining the bacteriological quality is to the fecal coliform count FC (on broth lactose at 44 °C), and fecal streptococci SF (on Sherman milk at 37 °C) by fermentation to multiple tubes (FTM) after 24 h of incubation. The law of fish allowed to estimate statistically the MPN of FC and SF supposed distributed in water at random and this based on 3 test of each series tubes seeding successive dilutions (1, 1/10 and 1/100) of liquid culture medium in the water to analyze [17], [18]

3. Results and Discussions

Have used the median (Me) distribution of experimental results which enabled us to discuss our results. The rate of drawdown (RD) medians of results allowed us to follow the evolution of the quality of the water before (0P1) and after processing of the output of factories (0P2) until the taps of users according to the age and the length of the network as the behavior of users.

For organoleptic and physicochemical analyses: n = 10 and n = 2 m; m = 10/2 = 5. Otherwise, the median is the average of 2 numbers in the middle.

$M_e = \frac{X_5 + X_6}{2}$ with $X_{m+1} = X_6$ and $X_m = X_5$

For bacteriological analyses: n = 3 and n = 2 m + 1 with m = 2/2 = 1.

Here, the median is the middle value.

$M_e = X_{m+1} = X_2$ [19]

The rate of drawdownRD (x) = $\frac{X_1 - X_2}{X_2}$x 100.

- : variable to the output of factories,
- : variable to the tap of usage [20]

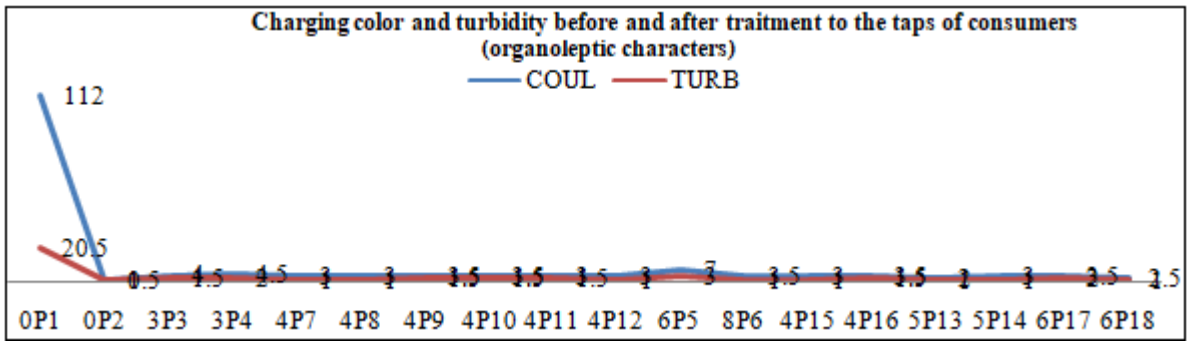

Figure 1: Evolution of the color and turbidity of the waters of capture at the exit of the TSHOPO factories until user taps

Figure 1 below shows very good drawdown rates between the capture and the output of factories after treatment.

Table 1 shows the evolution of the parameters of descriptors of the physical appearance of the waters in the low pressure (LP) or former network, day of heavy rain.

Table 1: Variation of colors and turbidities of 5 samples taken after a heavy rain

XPY	COLOR		TURBIDITY		RD/COLOR	RD/TURB	Observation
	Front	After	Front	After			
0P1	239	239	45	45	-	-	
0P2	**239**	**18**	**45**	**5**	**92,47%**	**88,88%**	**Very good (chain)**
3P3	18	9	5	3	50%	40%	Clarification to the network
3P4	18	7	5	3	61.11%	40%	Clarification to the network
6P5	**18**	**22**	**5**	**6**	**-22,22%**	**-20%**	**Pollution by sewage**

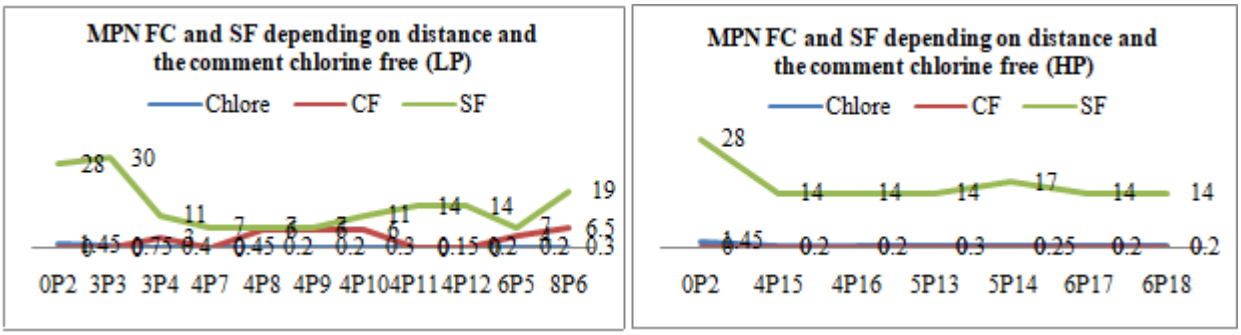

Figure 2a and 2b: Evolution of the NPP CF and SF (LP and HP) depending on distance and free chlorine content

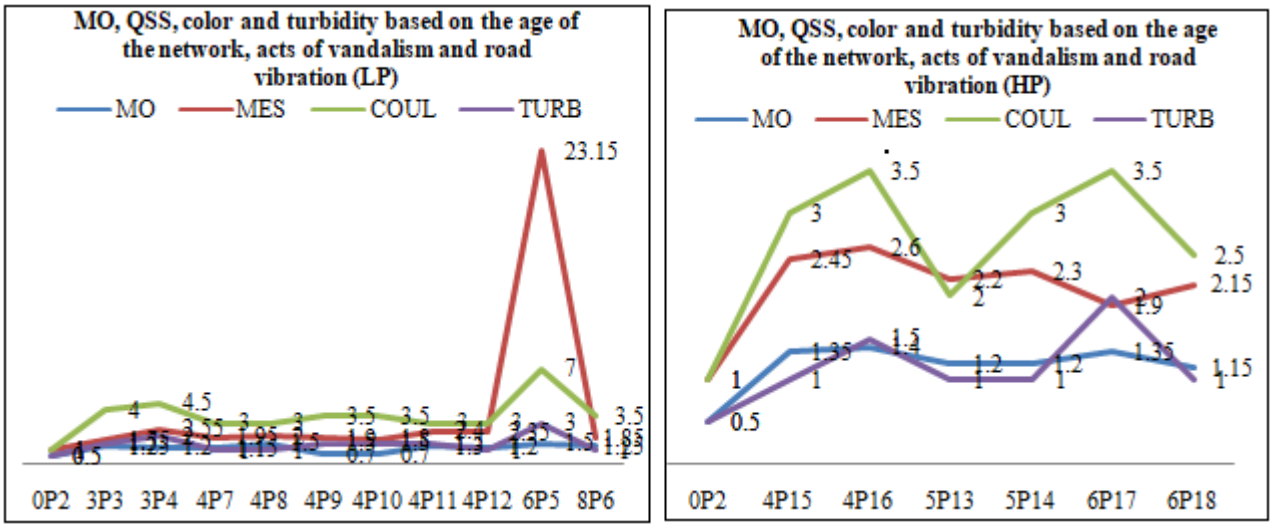

Figure 3a and 3b: Evolution of the M.O., QSS, Color, Turbidity content based on the age of the network, acts of vandalism and road vibration (BP and HP)

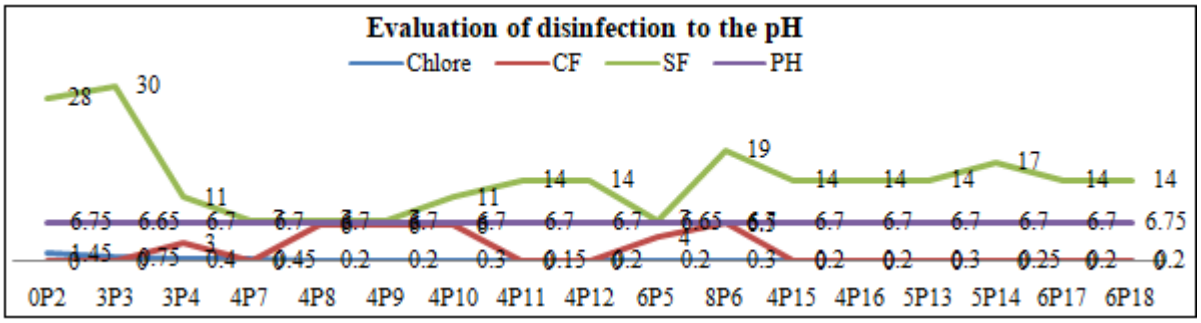

Figure 4: The NPP of CF and SF depending on the *p*H and chlorine-free.

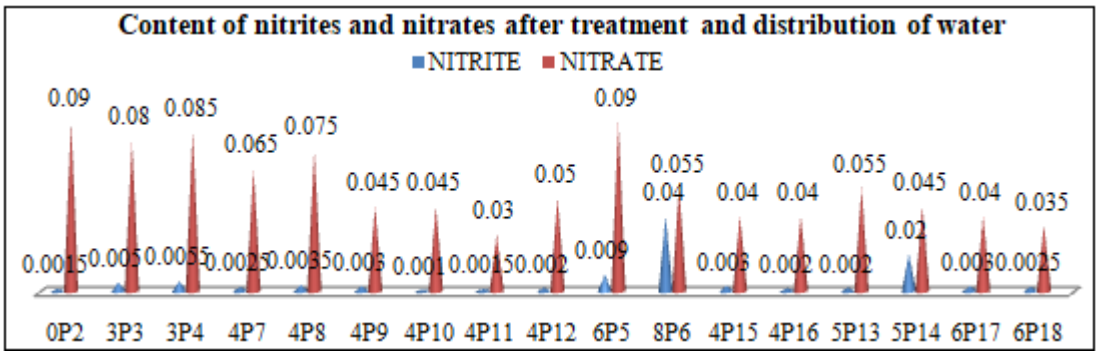

Figure 5: Evolution of makers in NO_3^- and NO_2^{--} to the grid (BP and HP)

In Figure 1, on 180 samples 2 only 1.17% is less good physical appearance. The median values of turbidity and color on 0P2 and 6P5 are slightly higher than the maxima of standards RD Congo, (NTU 0-4 and 0-15 Hazen). A major leak on 6P5 and the overflow of the Djubu-Djubu Creek the day of heavy rain would have a negative impact on the medians of these results. Following the mesh networks, pollution of these sites may somewhat affect the results of other sites not exposed to it.

In table 2, the rise of the turbidity in the catchment (OP1) values of the output factories (0P2) at in points 3P3, 3P4 and 6P5 to the old network (low pressure: LP) shows that the days of heavy rains the Tshopo river surface water is too busy and puzzle Island to deal with and the rate of drawdown of these 2 settings (92,47% and 88,88%) are above the standard DR Congo 80% confirms the effectiveness of the processing chain of Tshopo I & II plants. On the other hand, the RD (turbidity) of 40% and RD 50 and 61.11% between 0P2 - 3P4 and 0P2 - 3P4 (color) proves that the days of heavy rains, the clarification process continues to the network by excess of dosage of sulphate of alumina and the RD - 20 % (turbidity) and RD) Color)- 22,22% between 0P2 - 6P5 confirms a pollution by sewage through leaks, networks are particularly tighter to the LP network behavior.

Figures 2a and 2b show that 0P2 to all points of samples of 2 networks (LP and HP) Chlorine-free levels declined initially before stabilizing beyond 4 Km (4Pi) and the fall of the MPN in SF from 28/100 ml to 7 / 100 ml at the LP and 14/100 ml at HP. Therefore, sterilization continues to the network. On the other hand, between 0P2 and all points XPi from the HP (new network) the MPN are zero while on the XPi to the LP (old network) the MPN vary in saw teeth of 0/100 ml at 3; 6; 4 and 6.5.
We note that the LP is less waterproof points (corrosion of the pipes) than the HP that leaks, theft of water and contact with sewage related discharges within domestic. Thanks to the content of chlorine-free to exit the microbiological quality is excellent compared to the MPN of CF some XPi from the LP and all XPi from the HP. The rest of the XPi from the LP have of the MPN of FC superior to 0/100 ml proves a contamination of the water processed in the network. The MPN of SF of OP2 and XPi values in all 2 water distribution networks remain outsized DR Congo.

The content in chlorine-free at the exit of the factories (1.45 mg Cl_2/l) decreased bacterial density of CF and SF and the rise of these MPN at 6 points the LP XPi is justified by a microbiological to the LP network provided at HP we don't have no FC throughout with content in chlorine-free to 0.2 mg Cl_2/l than elsewhere in the LP. The SF seem resistant to the current process of disinfection. The age of the pipes network LP just start replacing pipes PVC (chloride of polyvinyl) and HDPE (high density Polyethylene), the involvement of the population to avoid the risk of pollution to the network as well as steel recovery point of prechloration improving the microbiological quality after final treatment. Potability standards, proposed by DUCHEMIN, to African realities classify water treated and distributed between good and very good quality and the health risk is low or non-existent following the tables 3 and 4 below

Table 3: Ranking of the various points of water according to the different classes of quality by DUCHEMIN [21]

Water quality	Very good	Pretty good	Average	Suspect	Mediocre	Bad	Very bad
FC/100 ml	0-20	0-20	21-200	200 - 1,000	1,001 - 5,000	5.001 - 20,000	> 20,000
SF/100 ml	0-20	20-200	21-200	200 - 1,000	1,001 - 5,000	5.001 - 20,000	> 20,000

Table 3 classifies the health risk due to consumption of contaminated water EAP of different levels of FC

Table 3: Classification of risks to health [22]

NO.	NPP FC/100 ml	Level of risk
1	0	None
2	1 to 10	Bottom
3	11 to 100	Intermediary
4	101 to 1,000	Top
5	More than 1,000	Very high

So, the dilapidated state of the LP network and the deterioration of health infrastructure as well as acts of vandalism and flights of water promotes the bacteriological pollution especially during heavy rains.

In the light of the figures 3a and 3b. Standards DR Congo, all chemical organoleptic parameters are very good gives excellent physicochemical quality waters. On the other hand, medians in the 6P5 important peaks are the result of a leak caused by an anarchic construction around an unhealthy environment which gave the maxima day of heavy rain.

Table 5 provides the environment for a maximum and effective disinfection.

Table 5: Distribution of 2 forms of free chlorine in water based on the pH at 25 ^{0} C [13], [20].

*p*H	5	6	7	7.5	8	9	10
% HOCl	**99.8**	**97.8**	**81.3**	50	30.3	4.2	0.4
% Col $^{-}$	**0.2**	**2.2**	**18.7**	50	69.7	95.8	99.6

In the light of the figures 2a, 2b and 4 show compared to [13], [20] and standards DR Congo that disinfection, *p*H from 6.65 to 6,675 and Temperature ranging from 21 to 27 ° C, OP2 end 2 networks has happened in the presence of 81.3 to 97.8% of the active form of chlorine that is ClO^{-}. Calcium hypochlorite disinfection happened in a perfect and appropriate environment.

The evolution of the MPN of the FC to the XPi 4 to 6 Km at HP and 3 to 4 Km to the LP (3P3, 4P7, 4P11 and 4P12) are zero. On the other hand, to the LP 3 to 8 Km (3P4, 4P8, 4P9, 4P10, 6P5 and 8P6) medians MPN of FC are 3; 6; 6; 6; 4 and 6.5).
The evolution of the medians MPN of the SF, of the output of the plants at all points of 2 networks, are superior of 0. At the LP they went from 28 to 30 for down to 7 and up 11, 14 and 19 while at HP, the MPN of SF went from 28 to 14 with a slight uphill to 17 to the 5P14.

The alteration of the microbiological quality of our waters is more to the LP to the HP and despite the distance of the point of withdrawal and the resistance of the SF XPi from the FC.

In figure 5, we found that the levels of ions nitrite (from 0.001 to 0.02 mg/l) and nitrate (0.03 to 0.09 mg/l) are by far lower than the maximum laid down by the WHO guidelines and standards DR Congo: 0-3 mg NO_2^{-}/l and 0-50 mg NO_3^{-} /l. Like most of the distribution networks the nitrate levels are low (without use of fertilizers, not development of farms, no fertilizer or explosives industries,...) and the self-purification of the shallow river Tshopo is the pollution is not important except after intense rains [13]

4. Conclusion

The health check to the consumer distribution network shows after processing and distribution of the findings below:

1) The SF are often more resistant to disinfection to HClO as FC although the chlorine residual continues to disinfect water treat to the faucet or conservation of water among users container,
2) The decline and rise of MPN of FC and SF, color, turbidity, OM and QSS; with important peaks to the point 6P5 (next to a major leak around an unsanitary environment) heavy rain days; is proof that the age of the pipes of the BP vandalism, the vibrations from road by big gear wheel as well as flights of waters are the major causes of pollution of these networks and the unwanted particles are spreading to more or less healthy network (HP) as a result of the mesh to the water distribution network designed like our circulatory system in which plants it is the heart and the pipes like the veins and arteries.

Firstly, the replacement of the dilapidated pipes, the rehabilitation of the collection system, piping and wastewater treatment may be the track to keep qualities physico-chemical and microbiological water processed in the network of distribution in the Kisangani region of the output of factories to consumer's taps.
On the other hand, the education of the population by current techniques of information and communication on the danger of mismanagement of human waste, and strengthening the capacity of public power to subsidize the sector and/or suppress any act likely to contribute to the alteration of our drinking water resources.

5. Thanks

We thank inwards LIMBELE, André TSHITENGE

References

[1] Code of ethics, REGIDESO S.A p8.
[2] courriel@regideso.com2015
[3] www.regideso.com2015
[4] KAZADI M.,: Contribution to the study of the quality and the management of water in the region of Kisangani. Thesis of doctorate in Sciences. University of Kisangani. Faculty of the Sciences.p4. 2012
[5] National Institute of statistics, Province Orientale (DR Congo). 2015.
[6] WWF: Comparative Analyses of the tap water and bottled water. Report en 2011, p6 drinking water, 42p. 2011.
[7] GAUTHIER F,: Biofilms and microbiological quality of drinking water during its distribution, memory of DESS, quality and water management. University of Picardy - Amiens, 78P. 2002
[8] P. AUBRY, and GAUZERE B. A.: water-related diseases. Tropical Indian Ocean, p1-3 medicine. 2012.
[9] MONAMA, o.,: instrumental methods. New courses. F.S. UNIKIS. DR Congo. P3. 2015.
[10] BEHRA P.; Chemistry and the environment. Lectures, case studies and exercises corrected. Campus LMD. Edition DUNOD, PARIS. 476p.
[11] HILL J. W. et *al*,: chemistry of solutions. 2nd edition. Edition of the educational renewal. Inc. Quebec City. Canada. pp412-414. 2008.
[12] HUGONIN P, (2011): Introduction to the themes of water. © ISE UNIGE. p24. 2011.
[13] RODIER J., LEGUBE, B., Martin N. *et al*,: water test. 9 thedition, © Dunod, Paris, 1.579p. 2009.
[14] LOMBA, b.: contributions to the study of the phytodiversity of the Forest Reserve of the Yoko (Ubundu, RD Congo).Des new memory. UNIKIS, 60 p. 2007
[15] HACH,: Hach Handbook of water Analysis, 232p.2000
[16] REGIDESO,: collection of the procedures of analysis. Training Center. Kinshasa, Zaire, 18 p. 1985.
[17] RODIER, J.: analysis of natural water, waste water and sea water. Dunod, ed., Paris. 1135p. 1978.
[18] LAMBERT: microbiology of food. Catholic University of Leuven - the - new, 123p. 1989.
[19] NGANDI,:the results of chemical analysis chemometric approach. Unpublished statistics courses. D.E.S. 2015

[20] ILUNGA: courses (module II) water treatment. REGIDESO/DFO. P27, 50-57. 2012.
[21] BEMMO N., NJINI T., NOLA M. and NGANDA D.: Technics used at the level of the suburban neighborhoods for the evacuation of waste water and excreta human. Final report. Yaoundé. 116p. 1998.
[22] WHO: the quality of drinking water guidelines. 2nd Ed. Volume 2. Hygiene criteria and supporting documentation. Genesis. 1050p. 2000.