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Evaluation of Water and Sanitation Situation of Rural Area near Landfill, Abidjan

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Abstract: Households Surveys in Akouédo and M'Badon villages have identified household methods of waste management by the people. It appears that in both villages there is no adequate method for managing household waste. Garbage is thrown into the wild uncontrolled dumps. In Akouédo, 93% of respondents and in M'Badon, 98% of respondents are provided with modern latrines, and the others discharged their excreta directly into the natural environment. In both villages, 42% of households dump their wastewater in pits, 29% in pipes and sometimes in the streets and yards. The population of both villages have access to safe drinking water (98-100%). In M'Badon well water is only used for bathing, laundry, dishes and 11% of households use it for drinking. Precarious sanitation and the presence of the dump pollute living environment and increases the risk of contamination of well water. The most recurrent diseases are malaria (33%), cold (27%) and diarrhoea (18%). However, the infant class is most affected.

Keywords: Sanitation, Water Resources, Health, Akouédo, M'Badon, landfill.

INTRODUCTION

Access to clean water and improved sanitation can be considered as one of the basic needs and rights of a human being [1]. But a large proportion of the world's population does not have access to adequate

drinking water and proper sanitation services [2, 3]. Most of these people live in developing countries [4]. The situation is especially alarming in rural areas, where a large majority (70%) of the people do not have access to proper sanitation and water supply services [5]. Population in developing countries has been constantly increasing and so has the needs in basic sanitation services (water supply, sewage and excreta, etc.) [6]. About 1.1 billion people worldwide lack access to improved drinking water supplies and use unsafe surface and groundwater sources [7, 8]. However, the water from these sources is often microbiologically contaminated [9-11].

The main sources of microbiological contamination of water are from human and animal waste, leakage from sewage networks, land disposal of raw sewage effluent without treatment, seepage from septic tanks and pit latrines, improper handling and storage of water at home [12]. The lack of access to safe drinking water and appropriate sanitation has many other serious repercussions [13]. This includes increasing in time and effort required for water collection, no promotion of economic activity, no strengthening of community organization, no improvement in housing, and ultimately, no improved quality of life [14]. Improved supplies contaminated with pathogens causing infectious diseases suchas cholera, enteric fever, dysentery, and hepatitis [7].

In Côte d'Ivoire, water supply and sanitation coverage is lower in rural areas than in urban areas. 91% of the urban population and 68% of the rural population have access to safe water and 36% of the urban population and 11% of the rural population have access to adequate sanitation [15]. Waste management and water supply are a great problem in rural areas near landfill of Côte d'Ivoire as well as other countries of the world.

Akouédo and M'Badon villages are near landfill which receives the waste of any kind from the district of Abidjan. Landfills may however pose serious threat to the quality of the environment if incorrectly secured and improperly operated [16-18]. The aims of the study are to assess the level of sanitation in Akouédo and M'Badon villages, to identify the different sources of water consumption and uses, to assess the health status of populations of these villages.

METHODOLOGY

Data Source: The study was carried in two villages at north-ast of Abidjan: Akouédo and M'Badon. They are located between the northern latitudes 588 000 and 594 000 m and West longitudes 396 000 and 400 000 m. These villages are near lagoon Ebrié and the Akouedo landfill which receives all the waste of the district of Abidjan. The people of these villages constitute the population of our survey. 10% of populations of each village were selected by quota sampling [19]. Thus 266 households in Akouédo and 407 households in M'Badon were surveyed.

A structured interview schedule with open-ended and closed-ended questions was developed. Data were collected through interview in September 2014. These data concerned the number of population by age, water sources supply and use, sanitation of the villages (wastewater, excreta and garbage management) and the population's health facing diseases such as malaria, diarrhea and skin and urinary diseases and other diseases. The health information mentioned takes into account the period of the previous 6 months before the survey began.

Water analyzing: The water samples were carried out only in the village of M'Badon where traditional wells are built to serve as water supply. According the distance between the lagoon, the latrines and the wells, village has been divided into three areas. The first area (P_1) gathers wells which are situated at 14 m of the lagoon and at 8 m of latrines. The second area (P_2) present well situated at

9 and 11 m of latrines. Wells by lagoon have constituted the third area (P_3). So, one well by area has been selected for analyze.

10 parameters have been determined in water samples: pH, NH_4^+, NO_3^-, NO_2^-, Pb, Ni, As, intestinal enterococci, bacteria coliform and *Escherichia coli*. The pH was measured using a pH-meter WTW pH 90. The concentration of NH_4^+, NO_3^-, NO_2^-, Pb, Ni and As of the samples were analyzed following the analytical standard methods (AFNOR) specific for each parameter. Microbial tests of Slanetz and Bartley were used to determine intestinal enterococci (NF EN ISO 7899-2). Bacteria coliform and *Escherichia coli* colonies were determine according to NF EN ISO 9308-1.

RESULTS AND DISCUSSION

Waste management: In these villages only 1% respondents undertake sorting of waste and rest of 99% do not practise sorting of waste prior to discharge. The sorted waste consists mainly of iron and aluminum that are recycled. In both villages surveyed, there is no pre-collection service and garbage collection that are produced. Households empty their own trash. There is neither an existing for treating waste in both villages. In Akouédo, populations discharged their waste in an authorized dumping site of the district of Abidjan, because it is near the village. On the contrary, M'Badon people stored their waste in dusbins, pits, vacant plots, streets and rains. This scenario is similar to Garoua-boulai Bertoua's in Cameroon 20, Makoda's, Kalyani's, Bona's, Churuli's and Jaurasi's in India 21. This situation could be explained by the lack of adequate infrastructure for managing household waste, but also by the lack of environmental education of the villagers.

Wastewater management: Figure 1 shows the proportion of the use of sanitation facilities identified in the studies villages. In the village of M'Badon, the highest portions of the respondents (38.57%) discharged their waste in pits, 35.13% of them discharged in pipes and 17.94% in garden. Only 1% of the population discharged their wastewater in the streets. Also, in the village of Akouédo wastewaters are mostly disposed in pits (46.24%) and pipes (23.31%). However, 18% of households discharged their wastewater into the street against 9.7% in the courtyard. In both villages investigated, cesspools and latrines are wastewater systems that at least used to remove wastewater produced. The use of street, pipes and courtyard by some households are not the appropriate places for throwing wastewater away. Unfortunately, they represent over 50% due to the lack of adequate sanitation [22].
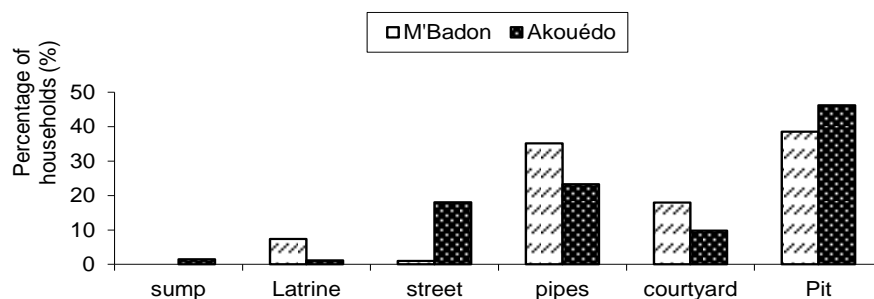

Figure 1: Different types of wastewater disposal in M'Badon and Akouédo villages.

Figure 2 shows the defecation areas surveyed households in the villages of Akouédo and M'Badon. On the other side, (93% in Akouédo and 99% in M'Badon) of the remaining households relieved

themselves in latrines. Defecation in latrine was a common practice as has been reported in other communities of developing countries [23-25]. Nevertheless, 60.46% of the surveyed households have latrines with septic permeable against 39.54% who have pit latrines impermeable. The latrine structural failure could cause septage leaks into the soil and groundwater. These pits pose a threat to groundwater and therefore to the health of populations that use well water in the area. Indeed, by mechanisms of infiltration and spread [26], groundwater would be exposed to fecal pollution from latrines.
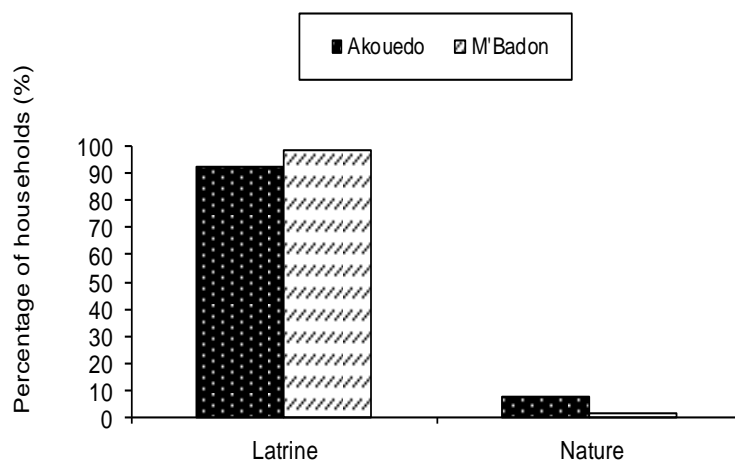

Figure 2: Percentage of defecation sites used in villages investigated.
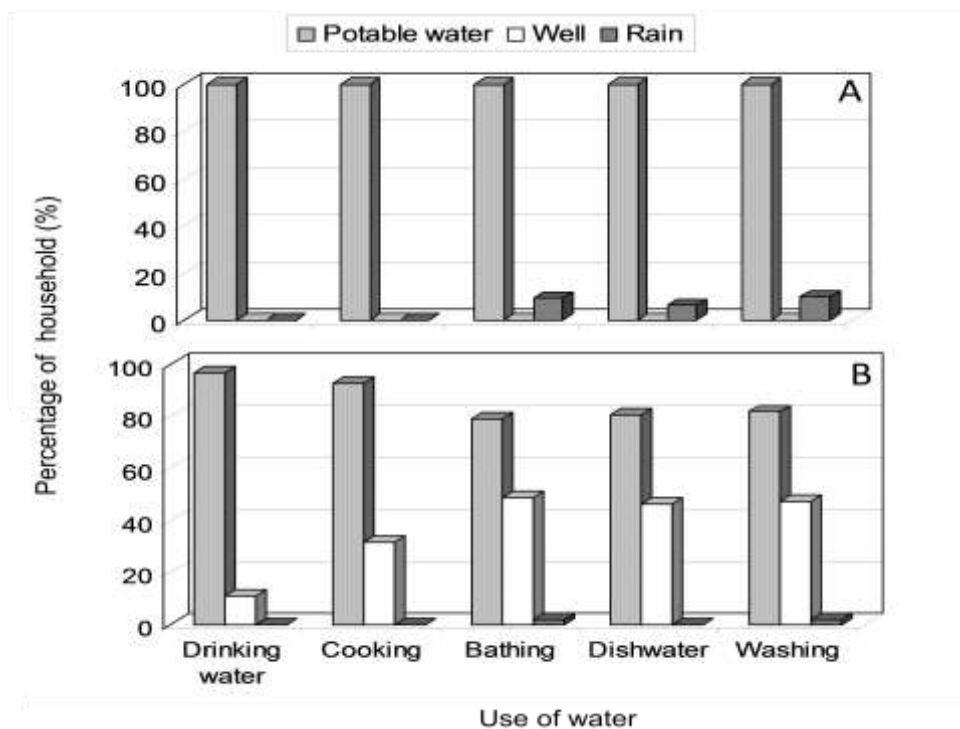

Figure 3: Utilizations of the water sources in Akouedo (A) and M'Badon (B) villages.

Water supply: Well, rain and potable water are the different water sources use in the investigated villages **(Figure 3)**. Potable water is distributed by only society (SODECI) which produces potable water in Cote d'Ivoire. This water is essentially used for all of the duties in Akouédo **(Figure 3A)**. Concerning M'Badon **(Figure 3B)**, the majority of respondents use potable water but well water is used as supplement for drinking, washing, bathing, cooking and as dishwater. The proportion of people using improved sources of drinking water increased because its availability. It can also be attributed to high investment in water resources services by Ivoirian government (personal subscription and private distributors) [27]. On the other hand, it would be linked to the sudden awareness of the people for water-associated diseases [28]. In M'Badon some households use well water in order to reduce their spending on water bills of SODECI.

Well water Quality in M'Badon: The different well and septic pit listed in the village are presented in **Figure 4**. In total, 25 wells have been found. We remark that septic pit are nearby well. Distance between septic pit and well vary at 1.9 m to 14.6 m. These distances are lower of advice distance (at 15 to 30 m). The values of the physico-chemical parameters of water of well are consigned in **Table-1**. The lowest pH (5.5) was recorded in the well P_2, following by well P_3 (pH = 6.3). The highest pH (6.9) was obtained in the well P_1. The acid character of wells is related to the nature of the soil. Other factors can explain acidity of water of well include owing to the fact that Akouédo landfill leachate are seeping into wells. Indeed, wells are downstream of the landfill and the decomposition of organic material in the garbage would have carried away leachate acidification. The leachate are seeping into wells and polluting it [26, 29]. Only the pH of well P_1 respect the WHO drinking water guide (6.5 < pH < 8.5) (WHO, 2008).
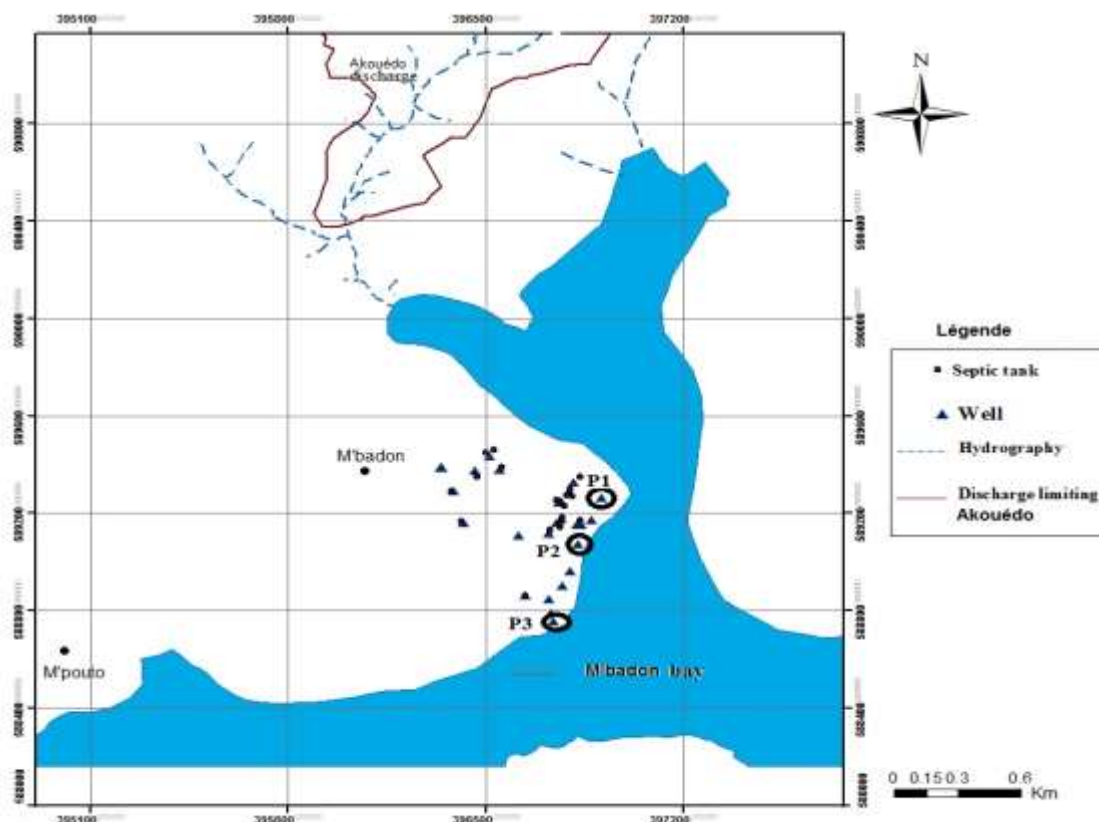

Figure 4: Map of differents wells and septic pit listed in M'Badon village.

NH_4^+ concentration (0.97 mg/L) is still higher in the well P_3. Well P_2 ranks second with NH_4^+ concentration of 0.57 mg/L, followed by the well P_1 (0.24 mg/L). Regarding NO_2^-, concentrations recorded in the different wells are very small. The values obtained are presented in the following sequence: NO_2^- of well P_2 (0.001 mg/L) < NO_2^- of well P_1 (0,013 mg/L) < NO_2^- of well P_3 (0,332 mg/L). Concentrations of NO_3^- respectively obtained in wells P_1, P_2 and P_3 are 9.47 mg/L, 51.2 mg/L and 50.7 mg/L. Concentrations of NH_4^+ and NO_3^- in well P_2 and P_3 are beyond accepted standards by WHO. The threshold values are 0.5 mg/L for NH_4^+ and 50 mg/L for NO_3^- (WHO, 2008). High concentrations of nitrogen compounds in well water would be related to the decomposition of organic matter but also the infiltration of leachate and wastewater [30].

The concentration of Pb in wells water P_3, P_2 and P_1 are respectively 0.027 mg/L, 0.024 mg/L and 0.016 mg/L. Concentrations of As are higher in the well P_2 (18.5 mg/L) than in wells P_1 (4.1 mg/L) and P_3 (3.7 mg/L). The concentration of Ni increase from 0.08 mg/L to 0.19 mg/L. Concentration of these heavy metals exceed the maximum permissible values by WHO (0.005 mg/L for Pb, 0.015 mg/L for As and 0.05 mg/L for Ni). The presence of these heavy metals would show the percolation of leachate from the Akouédo landfill in groundwater at M'Badon. Indeed, the leachate from the decomposition of landfill waste would drain the heavy metals and other pollutants in waste, and constitute a potential source of groundwater contamination when the water table is shallow, as in the case studied [11, 17].

This contamination is favored by the soil types hydromorphic, which are very sensitive to infiltration because of their soil characteristics (permeable soils, groundwater flush) [31]. Concerning the microbial test, well water in the village does not contain germs of coliform bacteria and *Escherichia coli*. Intestinal Enterococci are only present in the wells water from P_1 (710 CFU/100 mL) and P_2 (650 CFU/mL).These intestinal enterococci are encountered mainly in faeces of human and animal origin, and are an indicator of recent fecal contamination [32]. WHO recommends no colony in drinking water. The presence of these bacteria in well water is due to the fact that the wells are close to the latrines. Indeed, the distance between the latrines and wells does not meet international standards according [33] would be at least 15 m depending on and hydrogeological context of the area. Yet in this study, most of the wells are located within 10 m of latrines. The population of these villages (M'Badon and Akouédo) usually complain of illnesses related to the discharge, the effects of pollution are multiple odors.
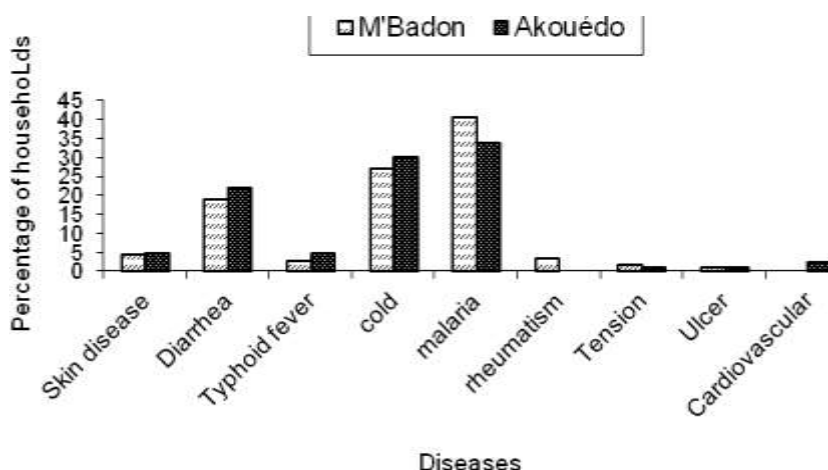

Figure 5: Diseases encountered in the villages of Akouédo and M'Badon.

Diseases manifested: The most recurrent diseases are malaria, diarrhea, and typhoid fever (**Figure 5**). The high rate of malaria (40.5% to M'Badon and 33.7% to Akouédo) can be explained by the pools of water that attract mosquitoes [34]. Over 27% of respondents in the two villages are affected by the cold. This is probably due to the nanoparticles from the discharge that would cause irritation to the respiratory breaths of the population. Diarrhoea is manifested in 18.92% to M'Badon and 22.09% to Akouédo. This situation is due to poor human excreta and waste management by household and quality of well water [15, 26].
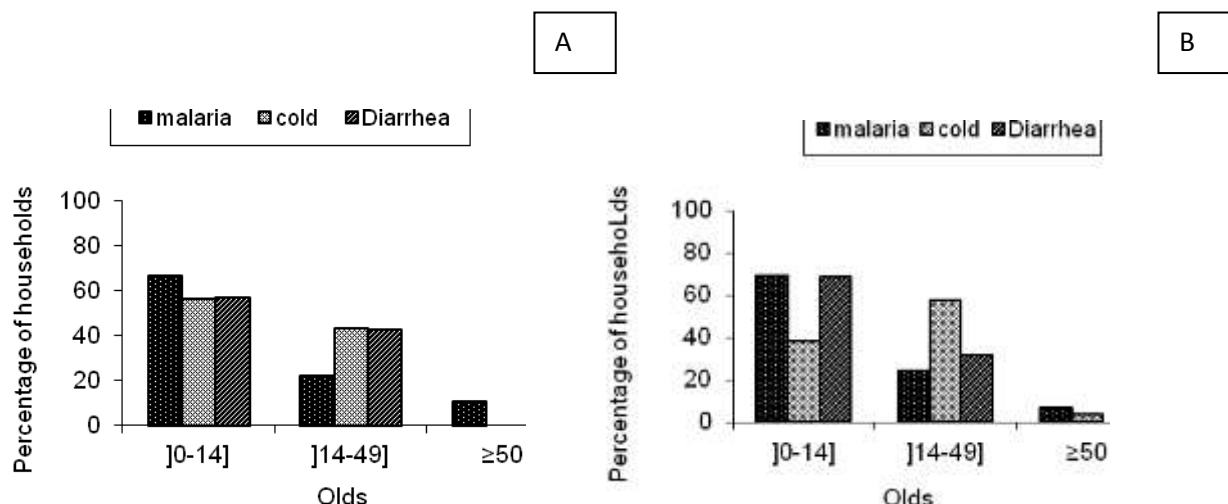

Figure 6: Proportion of dominant diseases by age group in M'Badon (A) and Akouédo (B) villages.

Figure 6 shows the proportion of households affected with malaria, cold and diarrhoea by age in both villages. Children [0 -14 years] (56%) are the most affected with these diseases. It is the same as the results of the works conducted in Yaoundé, Cameroon by Ngnikam *et al* [35] and the other one led in Abidjan, Cote d'Ivoire by Coulibaly *et al* [28] which revealed that children are the most vulnerable layer.

CONCLUSION

In both villages, there is no pre-collection system and collecting garbage. The domestic wastewater of Akouédo and M'Badon spilled mainly in pits and drains 42% to 29% against a rate of rejection in the street estimated at 18% in Akouédo and 1% in M'Badon. The discharge of sewage into the court is more practiced in M'Badon (18% of households) than Akouédo (10%).

The excreta disposal is mainly provided through autumn wastewater (SAA). However, 2-7% of the populations defecate in nature. Latrines are the most used (93-98%) in both villages. The pits of these latrines are mostly permeable. With respect to water resources, the people of both villages have access to potable water for drinking (98-100%). In M'Badon, in addition to potable water, 11% of households use well water for drinking.

The well water does not meet all the WHO guideline values for human consumption. Malaria, colds and diarrhea are the most frequently diseases encountered in the two villages. The portion of infant age [0-14] is the most affected with 66% of manifestations of malaria, more than 38% of colds and 57% of diarrhoea.

REFERENCE

1. S. Huuhtanen, A. Laukkanen. A guide to sanitation and hygiene for those working in developing countries. Tampere Polytechnic, University of Applied Sciences, Finland. 2006, 56.

2. A. Hoque, K. Hallman, J. Levy, H. Bouis, N. Ali, F. Khan, S. Khanam, M. Kabir, S. Hossain, M. S. Alam. *Int. J. Hyg. Envir. Heal.* 2006, **209**, 451-460.

3. M. Peter-Varbanets, C. Zurbrugg, C. Swartz, W. Pronk. *Water Res*. 2009, **43**, 245-265.

4. WHO/UNICEF, Publications of the World Health Organization, Geneva, 2006, 47.

5. WHO/UNICEF, Progress on sanitation and drinking-water. update. Publication WHO/ UNICEF .ISBN 978 92 4 150724 0. **78**, 2014.

6. J. P. Chippaux, S. Houssier, P. Gross, C. Bouvier, F. Brissaud. *Bull. Soc. Pathol. Exot*. 2002, **95** (2), 119 – 123.

7. M.D. Sobsey, C.E. Stauber, L.M. Casanova, J.M. Brown, M.A. Elliott. *Environ. Sci. Technol*. 2008, **42**, 4261–4267.

8. J.M. Arnal, B.G. Fayos, M. Sancho, G. Verdu, J. Lora. *Desalination*. 2010, **250**, 613-617.

9. X. Meng, G.P. Korfiatis, C. Chrstodoulatos, S. Bang. *Water Res*. 2001, **35**, 2805-2810.

10. WHO. Quantifying selected major risks to health. The World Health Report 2002, World Health Organization, Geneva, 2003.

11. S. Puttaswamaiah, Drinking Water Session of the IWMI-TATA 4th Annual Partners Meet, Anand, Gujarat, 2005.

12. WHO, Drinking water quality in the South-East Asia region. WHO Regional Office for South-East Asia. http://apps.searo.who.int/pds_docs/B4470.pdf, 2010.

13. J. Sadia, M. Qaisar, T. Sumbal, N. Bahadar, E. Noor, Jayub. *Med. Coll. Abbottabad*. 2011, **23**(1), 4.

14. A.J. Gadgil, E.A. Derby. Proceedings of the 96th Annual AWMA Conference, San Diego, CA, Air and Waste Management Association, Pittsburgh, PA, 2003.

15. WHO, Stratégies de coopération - un aperçu de la Côte d'Ivoire. Publication WHO. http://apps.who.int/gho/data/node.cco.1-2, 2014.

16. S.A. Erses, F.A. Mohammed, O.T. Turgut, C.H. William. *J. Haz. Mat. B*. 2005, **121**, 223 – 232.

17. K.I. Kouamé, D.L. Goné, I. Savané, K. Koffi, L.E. Koutouan, M. Diallo. *Sci. Nat*. 2006, **3** (2), 199 - 213.

18. E.O. Longe, M.R. Balogun. *Res. J. Appl. Sci. Eng. Technol*. 2010, **2**(1), 39-44.

19. A. Bhattacherjee. Textbooks Collection. Book. 2012, **3**, 159.

20. G.C. Bemb. Mémoire de DEA, Institut National de la Jeunesse et des Sports de Yaoundé, Cameroun. 2009, **122**.

21. R. Shah. *Int. J. Theor. Appl. Sci*. 2012, **4**(2), 72-75.

22. A. Morel, Programme gestion durable des déchets et de l'assainissement urbain, Rapport final. 2003, **197**.

23. A.M. Ingallinella, G. Sanguinetti, T. Koottatep, A. Montangero, M. Strauss, SANDEC, EAWAG. *Centro de Ingenieria Sanitario*. 2000, **8**.

24. M. Strauss, A. Montangero, A. Dembélé, Info CREPA. 2001, **32**, 15-25.

25. S. Yonkeu, A.H. Maïga, J. Wethé, M. Mampouya, G.P. Maga. *Vertigo.* 2003, **4** (1), 4778 – 4793.

26. A. Mbawala, Abdou, M. Ngassoum. *I. J. Biol. C. Sci*. 2010, **4**(6), 1962-1975.

27. BAD and OCDE, Rapport d'etude, BAD/OCDE, 2007, **10**.

28. L. Coulibaly, D. Diomandé, A. Coulibaly, G. Gourène. *Vertigo*. 2004, **5**(3), 3299 – 3310.

29. L. Martini, J.M. Moutou, M.S. Kongo-Mantono. *Afr. Sci*. 2009, **5**(1), 82- 98.

30. S. Bricha, K. Ounine, S. Oulkheir, N. El haloui, B. Attarassi. *Afr. Sci.* 2007, **3**(3), 391 - 404.

31. M.A.D. Tchibozo, L. Ayi-fanou, E. Lozes, R. Fadonougbo, D.J. Anago. *Int. J. Biol. Chem. Sci.* 2012, **6**(2), 592 – 602.

32. E.M. Clausen, B.L. Gren, W. Litsky. *Am. Soc. Test. Mater*. 1977, **635**, 247- 264.

33. CREPA. Bulletin d'information du programme d'assainissement écologique, 2009, **10**, 6.

34. K. Attahi. CRDI/Editions Karthala, chapitre 2. *Côte d'Ivoire*. 2002, 16-51.

35. E. Ngnikam, B. Mougoue, F. Tietche. *Rev. Actes.* 2007, 1-13.

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