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## The Car Laundromats of the City of Douala and the Risks Related to Human Health and the Environment



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### ABSTRACT

The objective of the work is to assess the effluents from car laundries in the city of Douala, then to carry out a physicochemical characterization by determining certain major and global parameters of the pollution of this wastewater and to identify the related risks. to human health. Samples were taken at car laundries in the city of Douala during February 2020. The physicochemical parameters were monitored using the techniques of Rodier (1996) and ONEP (1995). Temperature, hydrogen potential (pH), total dissolved solids (TDS), and electrical conductivity (C.E) is measured "in situ" using a portable multi-parameter (Consort C835; Hanna). The analysis of metals such as Cadmium (Cd), Nickel (Ni), Copper (Cu), and Iron (Fe) as well as Hydrocarbons (HC) in water were assayed with a MERCK brand UV-Visible spectrophotometer. Instruments with wavelength  $\lambda$  between 320 and 800 nm. It emerges from the results obtained that the wastewater from car laundries in the city of Douala as a whole has a practically neutral pH, close to acidic environments. The average temperature is 28.8°C and remains below the limit authorized for this type of discharge into natural environments. The average conductivity obtained is 412.22  $\mu\text{S}/\text{Cm}$ . The average iron content ([0.6-5.3 mg/L]) is well below the authorized limit. Hydrocarbons, metals copper, nickel, and cadmium have levels above the WHO standard and could constitute a danger to human health and the environment. The wastewater from car laundries in the city of Douala is much more loaded with copper pollutants followed by cadmium and nickel.

## 1. INTRODUCTION

Water, a very abundant liquid on planet earth, plays an important role in the development of living things. This is involved in all human activities (agriculture, construction, health, etc.). Water is a staple in most large businesses and in-car laundries in the city of Douala. After being used, most of this wastewater is returned to the environment. The World Health Organization (WHO) estimates that 80% of diseases affecting the world's population are directly associated with water, which implies the need to treat water before use (WHO, 1986). The maintenance of a vehicle necessarily involves washing it regularly to avoid the deposition of dust and the deterioration of the paintwork of cars by pollution and bad weather. There are two solutions for cleaning automobiles: high-pressure washing and manual washing. High-pressure washing is simply spraying the vehicle with a cleaning device that propels water at high pressure. This method is ideal for quick washes and makes it possible in particular to precisely clean hard-to-reach areas of the vehicle such as the side sills, the rims, or even the front and rear bumpers. Manual washing is this method that remains the longest, restrictive and it is necessary to know how to wash the car. Brushes, a bucket, sponges, rags, window cleaners are all essential tools for this task, but it is also possible to add, for example, a toothbrush to scrub the most inaccessible places. Whatever the method, the residues flow into the runoff water circuit, which is not always equipped to receive these pollutants, or infiltrate the soil or waterways, thus risking contaminating the water tables Information on water quality and sources of pollution is important for the implementation of strategic water use and sustainable management [1-3]. The problems associated with contamination by heavy metals and hydrocarbons were first highlighted in industrialized countries, due to their greater industrial developments, and especially following accidents due to pollution by the cadmium in Sweden and mercury in Japan [4]. Although the level of industrial activities is relatively lower in most African countries, there is a growing awareness of the need to rationally manage aquatic resources and in particular to control waste discharges into the environment [5- 8]. Several heavy metals are found in the aquatic environment, by human action, atmospheric transport, and as a result of erosion due to rain [9]. Thus, aquatic animals can be exposed to high concentrations of heavy metals [10]. This wastewater is a source of pollution for surface water and the ocean. They can be responsible for an irreversible ecological imbalance as well as the eutrophication of the waters of the receiving environment. The present work consists first of all in evaluating the effluents of the laundry

facilities in the city of Douala than in carrying out a physicochemical characterization by determining certain major and global parameters of the pollution of this wastewater and to identify the risks associated with human health and the environment.

## 2. MATERIALS AND METHOD

### 2-1. Study site

The city of Douala is located in the coastal region of Cameroon in Central Africa. The geographical coordinates of Douala are as follows: Latitude: 4°02'53 " North, Longitude: 9° 42'15 " East, altitude above sea level: 19 m. Figure 1 represents the Map of the city of Douala which highlights the different Boroughs as well as the sample collection sites.

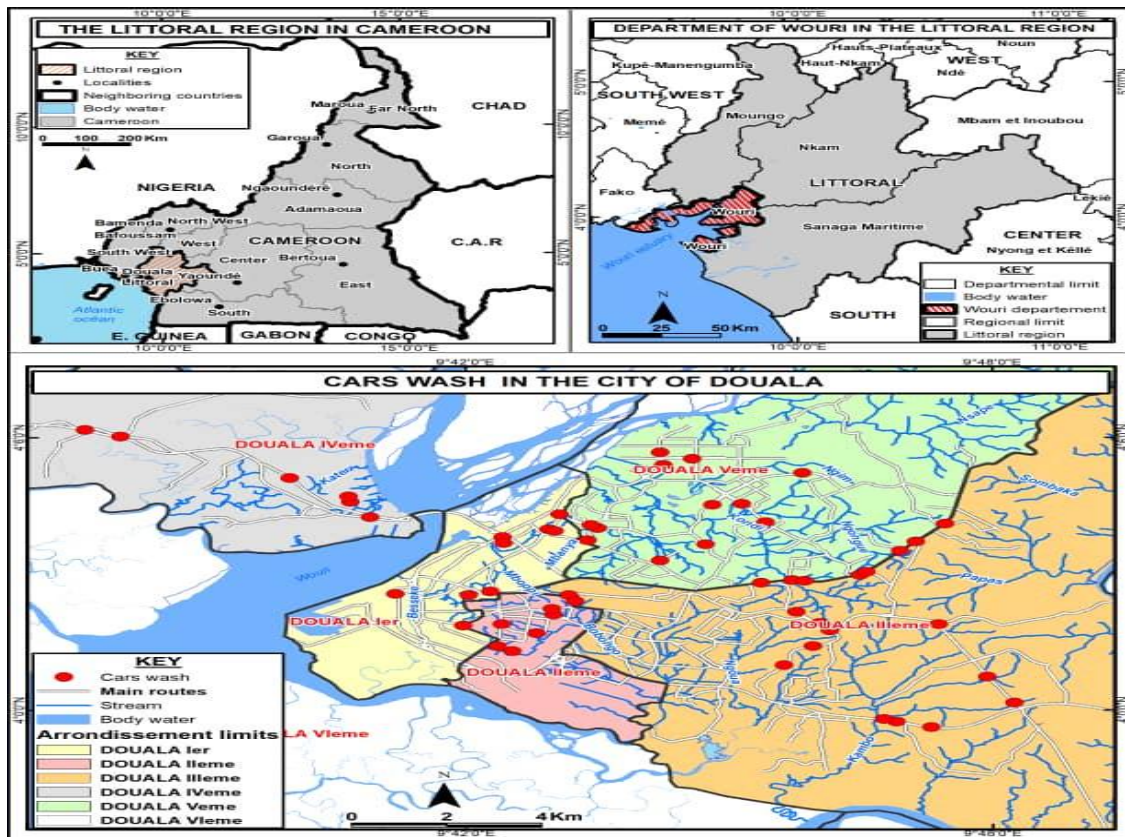


Figure No. 1: Map of the city of Douala with its different Borough

## 2-2. Sampling and analysis of wastewater from laundry facilities

The samples were taken at the car laundries in the city of Douala during February 2020. Samples were taken at the various sites shown in Figure 1 once a day for the duration of the work. The water samples are collected in 500 ml vials and stored in the cooler refrigerated (4 °C) until the time of analysis. The physicochemical parameters are monitored using the techniques of Rodier (1996) and ONEP (1995). Temperature, hydrogen potential (pH), total dissolved solids (T.D.S), and electrical conductivity (C.E) is measured "*in-situ*" using a portable multi-parameter (Consort C835; Hanna). The analysis of metals such as Cadmium (Cd), Nickel (Ni), Copper (Cu), and Iron (Fe) as well as Hydrocarbons (HC) in water was carried out using the UV-spectrophotometer. Visible MERCK Instruments brand with wavelength  $\lambda$  between 320 and 800 nm.

## 3. RESULTS AND DISCUSSION

The city of Douala was the geographic area of our work where we covered 5 out of the 6 districts. The laundries were chosen in this area. The measurements and laboratory analysis of the samples taken allowed the following parameters to be determined: pH, temperature, electrical conductivity, total dissolved solids, hydrocarbons, iron, copper, nickel, and cadmium. Thus, a table of results by the district has been drawn up.

### 3-1- Physico-chemical analysis of wastewater from laundry facilities in the Borough of Douala 1<sup>st</sup>

Table no. 1 group together the various physicochemical parameters measured in the water of the laundry facilities in the Borough of Douala 1<sup>st</sup>.

**Table No. 1:** Different physicochemical parameters measured in the water of laundry facilities in the Borough of Douala 1<sup>st</sup> (1ppm = 1mg/L)

Borough of Douala 1 <sup>st</sup>									
Location Parameters analyzed of the Laundromat or collection point in Douala 1 <sup>st</sup>	pH	T°C	Conductivity µs/cm	T.D.S mg/l	HC ppm	Copper Cu ppm	Iron (Fe) ppm	Nickel (Ni) ppm	Cadmium (Cd) ppm
Bonateki Axe	6,87	28,2	311	162	2,55	2,1	0,11	0,31	0,14
GraveyardNjo- NjoBonapriso	6,57	28,2	418	221	16,1	4,1	2,46	0,17	0,11
Ront point deidobehindboulangerie meno	6,34	28,2	629	332	3,35	6,7	0,12	0,15	0,08
Ancien collège des travailleurs	6,74	28,1	728	390	13,5	5,6	0,26	0,59	1,88
Poste centrale	6,71	28,2	423	220	35,5	8,1	0,19	0,27	1,74
Château Beside the CDE Deido	6,59	28,2	278	153	50,3	10,12	0,60	0,12	2,55
Face safelbonatoneDeido	6,9	28,1	576	308	31,5	13,2	0,51	0,4	3,08
behindthe école public de Deido	5,36	28,2	229	130	16,4	1,85	0,68	1,5	3,35
Bonapriso carrefour kapawa	6,67	28,2	318	172	2,41	0,95	0,41	0,77	3,51

The results obtained show that the pH, whatever the sampling point, is slightly less than 7 with a minimum of 5.36 at the discharge point of the laundry behind the DEIDO public school. We can say that these waters are slightly acidic. This acidity makes these effluents conductors of electric current for the most part. The temperature of the discharged water is constant at 28 °C for all the laundry facilities in the Borough. The temperature remains below the acceptable limit for discharges into the natural environment: 30 °C. This does not pose a problem for the environments receiving these effluents from the laundry facilities in the Arrondissement of Douala 1er. Taking into account the relationship between the conductivity and the mineralization

of the wastewater from the various washing facilities, it is noted that the wastewater from four laundries has a conductivity of between 200  $\mu\text{s}/\text{cm}$  and 333  $\mu\text{s}/\text{cm}$  their mineralization is said to be moderately accentuated. The wastewater from four other washing plants has a conductivity varying between 333  $\mu\text{s}/\text{cm}$  and 666  $\mu\text{s}/\text{cm}$ , its mineralization is said to be accentuated. The wastewater from a single laundromat: a former workers' college, has a conductivity of between 666  $\mu\text{s}/\text{cm}$  and 1000  $\mu\text{s}/\text{cm}$ ; their mineralization is then said to be important [11] It is noted that the water discharged by the laundries has a conductivity varying between 200  $\mu\text{s}/\text{cm}$  and 728  $\mu\text{s}/\text{cm}$  values which correspond to variations in the levels of mineralization from moderately accentuated to high; thus corresponding to hard waters [11,12]. The total dissolved solids have, for all the wastewater from these laundries, values between 130 mg/L and 390 mg/L. According to the discharge standards of thirteen countries (Australia, Belgium, Denmark, France, Great Britain, Holland, Hungary, Italy, Poland, Switzerland, Canada, India, Egypt), these waters are considered excellent for a dissolved mineral matter that they contain.

**Hydrocarbons (HC):** The results of this parameter show that three out of nine laundries have levels in this discharge water below the standards, in particular the Algerian standards where the discharge limit is set at 10 mg/L [13] and French standards where this limit is set at 5 mg/L [14]. Also, three of the six laundries whose wastewater has HC contents above the standard are heavily polluted with concentrations three to five times higher than the limit required by the regulations. These are central post laundromat, laundromat opposite SAFEL BONATONE DEIDO, and castle laundromat next to CDE DEIDO. The presence of hydrocarbons in wastewater discharged from washing facilities into receiving environments (surface water, soil, and subsoil, flora, and fauna) can have adverse effects on health and the environment. People who use water from wells and even rivers for their needs, and exploit the soil for certain crops, are exposed to the long-term carcinogenic or mutagenic effects of hydrocarbons even at low doses [15]. The environment will also be affected by the impoverishment of aquatic ecosystems (decrease in animal and plant populations) [15], the reduction in biological diversity, and the self-purification capacity of aquatic environments [15]. **Copper (Cu):** We note that the wastewater from all the laundries has copper contents above the required limit value. Two of the nine laundries have copper contents below the threshold admissible by French regulations (2mg/L) [14]. Algerian regulations provide for the limit of industrial wastewater discharges with copper contents of 0.5 mg/L in natural environments [13], so all of our laundries have rates

above this threshold. The presence of this pollutant in wastewater from laundry facilities could be caused by the wear of tires, brake linings, bodywork, and other metal parts of the vehicle [16]. It is also possible that it comes from leaking fluids such as lubricating grease, antifreeze, brake fluid, or transmission fluids [16]. High levels of copper in water could have negative effects on human health as well as the environment. The excess of copper in the water could be the cause of the decrease in a photosynthetic activity which alters the gills of fish and causes a delay in their laying. In humans, it causes gastroenteritis, cirrhosis of the liver, necrosis, sclerosis.

**Iron (Fe):** The results of the analyzes of samples taken from the wastewater from the nine laundry facilities in the Arrondissement of Douala 1er show that the iron content of this water is below the thresholds admissible by French regulations, 5 mg/L [14] and Algerian 3mg/L [13] for the discharge of industrial effluents into natural environments. This pollutant can come from the corrosion of certain metallic parts of the vehicle [16]. This metal therefore does not cause any health effects on the populations of this locality and is not a nuisance for the environment.

**Nickel (Ni):** Just like iron, the results obtained after analyzes of samples of the wastewater from the Douala 1er laundries show nickel contents well below the limit of 2 mg / L admissible by French regulations [17] for the discharge of industrial effluents into receiving environments. However, about Algerian regulations, it should be noted that three of the nine laundries have their contents above the admissible limit which is 0.5 mg/L [13]. This pollutant in the wastewater is thought to come from the wear of tires, brake linings, and fluids such as brake fluids [16]. This metal would not pose a nuisance to the environment of this town of Douala and its populations.

**Cadmium (Cd):** The results in Table 1 show the variations in cadmium levels from one laundromat to another with values between 0.11mg/L and 3.51mg/L. However, for industrial effluents to be discharged into the natural environment such as wastewater from laundry facilities, the regulatory limit for these cadmium contents is set at 0.2 mg/L [13, 14] We note that two-thirds of the effluents from laundry facilities in the Douala 1er district have cadmium levels above the regulatory limit. This metal in laundry wastewater is believed to come from the wear of tires, brake linings, paints, or coating [16]. This exposes the environment of this locality to various ecological effects, namely: acute toxicity on organisms and algae from 0.1 mg/L [18]; an accumulation in the trophic chain. The possible health effects on humans may be cumulative: acute toxicity, renal damage, hepato-digestive disorders, blood disorders, bone deformation

(cracking), nervous disorders (paralysis), an inhibitor of reactions related to respiration, and the enzymatic systems.

### 3-2- Physico-chemical analysis of wastewater from laundry facilities in the Borough of Douala 2<sup>nd</sup>

Table no.2 groups together the various physicochemical parameters measured in the water of the laundry facilities in the district of Douala 2<sup>nd</sup>.

**Table No. 2:** Different physicochemical parameters measured in the water of the laundry facilities in the district of Douala 2<sup>nd</sup>

Parameters analyzed location of the Laundromat or collection point in Douala 1 <sup>st</sup>	Borough of Douala 2 <sup>nd</sup>								
	pH	T°C	Conductivity µs/cm	T.D.S mg/l	HC ppm	Copper Cu ppm	Iron (Fe) ppm	Nickel (Ni) ppm	Cadmium (Cd) ppm
Ancien 3 <sup>ème</sup> besidehuawei	6,78	28,8	332	169	85,3	5,22	3,12	2,87	5,68
Nganguebeside chefferie bloc 6	7,16	28,7	803	422	62,1	9,91	10,25	3,64	8,33
Kilomètre 5 besideclub 105	7,04	28,7	334	180	38,8	8,85	7,22	0,5	2,21
Kilomètre 5 besideexpress union	6,86	28,7	419	223	23,9	7,57	6,40	1,44	4,85
Foyer culturel of bayangam	7,32	28,9	468	254	16,7	10,6	10,21	2,1	4,36
Behind the collegesacrecoeur	7,09	28,8	310	157	35,8	6,61	0,55	3,45	3,31
New bell boulevard des nations	6,8	28,8	440	226	60,3	3,59	3,25	0,05	2,16
Pont central bar face winner chapelle	7,29	28,9	1520	810	33,3	3,05	1,12	0,65	5,98



The wastewater from laundry facilities in the 2<sup>nd</sup> Borough of Douala has a pH that varies between 6.78 and 7.32. We can say that these waters are neutral from the point of view of pH, therefore are weak conductors of electric current. The temperature of these waters hardly varies and remains below the authorized limit for effluent discharges into the natural environment, which is 30 °C [13]. The conductivity of the wastewater from laundry facilities in the 2<sup>nd</sup> district of Douala varies from 310 µs/cm to 1520 µs/cm. These conductivity values are all greater than 200 µs/cm, the acceptable limit value for wastewater in the natural environment [17]. From these conductivity values, we can say that these waters vary from accentuated mineralization to high mineralization passing through significant mineralization. The total dissolved matter of this laundry wastewater remains below the authorized limit for discharges of industrial effluents into the natural environment, according to the discharge standards of thirteen (13) countries: 1000 <TDS <2000 mg/L (Australia, Belgium, Denmark, France, Great Britain, Holland, Hungary, Italy, Poland, Switzerland, Canada, India, Egypt).

**Hydrocarbons (HC):** The hydrocarbon contents of the wastewater from the laundry facilities in the 2<sup>nd</sup> Borough of Douala are all above the authorized limit for discharges of industrial effluents in the receiving environment. These values are, for most laundries, more than three times higher than the authorized release limit in the natural environment, which is 10 mg/L [13]. Among these laundries, three stand out for their effluents heavily polluted with hydrocarbons with contents of 60.3 mg/L, 62.1 mg/L, and 85.3 mg/L. These are respectively NEW BELL Boulevard des nations, NGANGUE next to the chieftaincy block 6, former 3<sup>rd</sup> next to Huawei. This heavy pollution of the discharge water from these laundries can be linked to accidental oil spills by vehicles in these laundries. The populations and the environment of this district are much more exposed to the effects of this pollution.

**Copper (Cu):** The copper contents of the wastewater from the laundry facilities in the Borough of Douala 2<sup>nd</sup> are very high compared to the authorized limit for discharges of industrial effluents in the natural environment: 0.5 mg/L. The copper concentrations in this wastewater vary from 3.0mg/L to 10.60mg/L. These discharges, highly polluted with copper, are discharged into the receiving environments without any prior treatment. Some of these discharges will end up in waterways and others will reach the water table the following infiltration because the soil of the city of Douala is porous and its water table close to the surface [19].

**Iron (Fe):** We note that four out of the eight laundries whose wastewater was analyzed have iron contents above the authorized limit (5 mg/L) [14]. On the other hand, the World Health Organization recommends not to exceed 0.3 g/L (300mg/L), because it is not good for the digestive system (O.-P.-S., 1987) [20]. However, it should be noted that these values are relatively low to cause a health risk in humans. However, it should be noted that it can have a possible carcinogenic effect by combining benzo [a] pyrene (B [a] P) with ferrous oxide particles considered to be cofactors [21-24]. Iron very often plays an important role in the transfer of the metal arsenic in the waters of the subsoil. The oxidation of iron in aquatic environments has harmful effects on its environment. This is the case of the aquatic flora which is covered with a layer of rust of orange color with a red-brown tendency which can be very dark [25] preventing any other exchange between the plants and their living environment: example of crusted plants. [26].

**Nickel (Ni):** The wastewater from five out of eight laundries has nickel contents above the permissible limit, which is 1 mg / L for discharges of industrial liquid effluents into the natural environment. These nickel contents vary between 0.05mg/L and 3.64mg/L with particularly very high values of 2.87mg/L, 3.45mg/L, and 3.64mg/L respectively for the laundries located at the points: Old 3rd next to Huawei, behind Sacre-Coeur college, and NGANGUE next to the chiefdom of block 6. This metal, present in certain parts of the vehicle such as tires, brake linings, bodywork, and other metal parts, and the brake fluid, can be found in the wastewater of laundries after washing these machines [16]. These points must be the subject of special monitoring to ensure that the levels of this metal in the wastewater do not exceed the standards before they are discharged into the receiving environments.

**Cadmium (Cd):** The wastewater discharged by the laundries in the 2<sup>nd</sup> Borough of Douala is heavily loaded with cadmium metal with levels varying from 2.16 mg/L to 8.33 mg/L. These values are well above the limit value authorized by the standards of the WHO, the European Union, Algeria, and many other countries. The harmful effects of pollution by cadmium metal on the environment and humans were presented in the analyzes made of samples of wastewater from laundry facilities in the 2<sup>nd</sup> Borough of Douala. Much more particular attention should be paid to this water before it is discharged into the receiving environment. More specifically, it will

be a question of seeing the appropriate type of treatment to be given to these liquid effluents from the laundries so that they are authorized to be discharged into the receiving environment.

### **3-3- Physico-chemical analysis of wastewater from laundry facilities in the 3<sup>rd</sup> district of Douala**

Table no 3 groups together the various physicochemical parameters measured in the water from the laundry facilities in the 3<sup>rd</sup> district of Douala.



**Table No. 3:** Different physicochemical parameters measured in the water of the laundry facilities in the 3rd district of Douala

Parameters analyzed location of the Laundromat or collection point in Douala 3 <sup>rd</sup>	Borough of Douala 3 <sup>rd</sup>								
	pH	T°C	Conductivity µs/cm	T.D.S mg/l	HC ppm	Copper Cu ppm	Iron (Fe) ppm	Nickel (Ni) ppm	Cadmium (Cd) ppm
Pk 9 -centre Educatif château	6,89	27,9	280	150	41,5	6,66	7,58	1,28	2,25
Pk 13-face central inforbifor express union	6,99	28,1	250	132	20,2	2,42	0,00	0,05	2,37
Face pharmacie louxiyanyalla	6,46	28	90	52	28,7	6,18	3,25	4,47	3,02
Yassa -Vrai Eglise de Dieu	6,95	28	533	283	77,7	7,75	0,31	3,79	6,22
Ngodibakoko face express union -clinique de jeanne	7,55	28,1	520	276	74,3	2,05	0,00	0,07	1,14
Pk 11-face tradex carrefour genie	7,01	28,1	433	229	24,6	1,64	0,16	1,02	1,20
Yassa- entrance ENIET	6,85	28	288	148	4,55	1,76	0,34	4,22	3,09
Parking- laverie de l'avenir	6,98	28,2	301	163		3,31	5,58	1,61	3,4
Ngodibakokobeside the hobofeglisepentecotiste	6,75	28	246	128	69,3	2,88	2,15	1,86	2,38
Ngodibakokocarrefour henry beside the auto- ecole alliance	6,73	28	210	111	13,7	2,4	3,95	0,07	1,66
Pk 11-laundromat-garage francis moto	6,84	28,1	266	144	6,55	2,07	0,55	0,49	0,7
Pk8 laundromat before the market	6,87	28,2	332	166	47,9	6,69	0,35	0,06	0,39
Ndogpassi 2 face bocom	6,88	28,2	290	149	39,6	3	1,22	0,08	0,48
Logbaba face pel church	7,16	28,1	354	179	17,9	2,44	3,69	0,35	7,2
Ndogpassi 3- fondation st espoir pour tous	6,78	28,2	261	144	27,3	7,78	1,59	0,04	0,54
Pk 10 bifor carrefour genie	6,61	28,2	133	71	16,3	2,16	2,87	0,09	4,1

The pH of the wastewater from laundry facilities in the 3<sup>rd</sup> Borough of Douala varies very little between 6.46 and 7.55. By comparing these pH values with those of the laundries in the Borough of Douala 1<sup>st</sup>, which are between 6.87 and 5.36, we see that the pH of the wastewater from the laundries in the Borough of Douala 3<sup>rd</sup> is less acidic than that of the laundromats of the Borough of Douala 1<sup>er</sup>. Consequently, the wastewater from laundry facilities in the Borough of Douala 3 is not very conductive of current compared to the wastewater from the laundry facilities in the Borough of Douala 1. The temperature varies between 27.9 °C and 28.2 °C. These values remain below the limit value authorized by the 30 °C standards. We can say that the temperature of the liquid discharges from the laundry facilities in the 3<sup>rd</sup> Borough of Douala does not have a significant influence on the receiving environments that receive this wastewater. The conductivity of the wastewater from these laundries varies between 90 µs/cm and 533 µs/cm, thus corresponding to a variation in the mineralization of these liquid effluents between very low and accentuated levels. The wastewater from two-thirds of these laundries has low mineralization. We can thus say that these waters are weakly conductive. Their impact is not significant on the receiving environments where they are discharged. The total dissolved solids have, for all the wastewater from these laundries, values less than 300 mg/L. According to the discharge standards of thirteen countries (Australia, Belgium, Denmark, France, Great Britain, Holland, Hungary, Italy, Poland, Switzerland, Canada, India, Egypt), these waters are considered excellent for a dissolved mineral matter that they contain.

**Hydrocarbons (HC):** The wastewater discharged by the laundry facilities in the 3<sup>rd</sup> Borough of Douala is laden with hydrocarbons because two-thirds of the samples taken have levels higher than the authorized standard for discharges of industrial liquid effluents in the natural environment. Concerning the values higher than the authorized limit, these vary between 20.2 mg/L and 77.7 mg/L. We can cite in ascending order, the discharge points of NGODI BAKOKO next to the Pentecostal church plaque (69.3mg / l), NGODI BAKOKO face express union, and clinic of Jeanne (74.3mg/L) and, Yassa-True Church of God (77.7 mg/L).

**Copper (Cu):** Analyzes of samples taken at the discharge points of all the laundry facilities in the 3<sup>rd</sup> Borough of Douala give copper contents higher than the authorized limit for any discharge of industrial liquid effluent in a receiving environment. These values vary between 1.64mg/L and 7.78mg/L and the admissible limit is set at 1mg/L. The environment of the 3<sup>rd</sup> district of Douala

as a whole is exposed to significant copper pollution from wastewater from laundry facilities. This is how the populations of this locality are exposed to the harmful effects of copper pollution with all that this can have as a consequence in the short, medium, and long term in their lives.

**Iron (Fe):** Almost all of the samples taken at the discharge points of laundry facilities in the 3<sup>rd</sup> district of Douala have iron contents in the wastewater below the acceptable limit which is 5 mg/L for industrial effluent discharges in a natural environment. These iron contents vary from 0.00mg/L to 7.58mg/L much lower compared to the authorized limit for these discharges outside two of the laundries: Pk 9-educational center castle and parking lot and laundromat of the future. The discharges of wastewater from laundry facilities in the 3<sup>rd</sup> district of Douala as a whole could not pose a problem for the populations and the environment in this part of the city.

**Nickel (Ni):** In the wastewater from the laundry facilities in the 3<sup>rd</sup> district of Douala, we observed a variation in the nickel content of between 0.04 mg/L and 4.22 mg/L. Also, nearly half of these samples (seven out of fifteen) have to nickel contents above the discharge standard (1 mg/L) authorized in the natural environment. Three of the seven laundries have wastewater that is particularly loaded with nickel pollutants. We can cite in ascending order: Yassa-VraiEglise de Dieu 3.79 mg/L, Yassa entry ENIET 4.22mg/L and, opposite the pharmacy LOUXIA NYALLA 4.47mg/L. It is important to regularly monitor spills from these laundries and to define the means of treating these effluents with this pollutant before discharge into the natural environment.

**Cadmium (Cd):** Almost all of the results obtained give cadmium contents greater than the authorized release limit of this pollutant in the natural environment (0.2 mg/L) [13, 14]. Unlike other pollutants, we note the presence of cadmium throughout the geographical area of the 3<sup>rd</sup> district of Douala at significant concentrations. It should therefore be one of the first pollutants on which attention should be focused when controlling the pollutants released into nature by the wastewater from laundry facilities.

### **3-4- Physico-chemical analysis of wastewater from laundry facilities in the 4<sup>th</sup> district of Douala**

Table no. 4 groups together the various physicochemical parameters measured in the water of the laundry facilities in the 4<sup>th</sup> district of Douala.

**Table No. 4:** Different physicochemical parameters measured in the water of laundry facilities in the district of Douala 4<sup>th</sup>

Parameters Analyzed location of the Laundromat or collection point in Douala 3 <sup>rd</sup>	Borough of Douala 4 <sup>th</sup>								
	pH	T°C	Conductivity µs/cm	T.D.S mg/l	HC ppm	Copper Cu ppm	Iron (Fe) ppm	Nickel (Ni) ppm	Cadmium (Cd) ppm
Face société mayor bonaberi	6,85	28,1	617	334	32,3	5,59	2,60	0,63	2,1
Face Nosucabonaberi	6,68	28,1	446	241	68,2	6,62	0,38	0,52	0,74
Face boulangerie du lyceeBonaberi	6,56	28,1	318	170	10,52	3,28	0,20	0,88	0,05
Fin goudron bonamekano à côté de facebook	6,33	28,1	330	179	17,70	5,87	0,11	0,07	0,67
laundryoilybiabonassama	6,89	28,1	407	218	35,2	7,24	2,71	0,06	0,55

The wastewater from laundry facilities in the Borough of Douala 4<sup>th</sup> has a pH value that varies between 6.33 and 6.89. This shows the slightly acidic character of these wastewaters. These values are within the range of pH authorized for discharges of industrial wastewater into a receiving environment. We can say from the point of view of the pH, that these waters conduct electric current very weakly. The temperature of the discharged water from the laundry facilities in the Borough of Douala 4<sup>th</sup> is constant at 28.1 °C, a value lower than the limit value of 30 °C authorized for this type of discharge in the receiving environment. This parameter, therefore, has no negative influence on the natural environment where this wastewater is discharged. The conductivity values of this wastewater vary between 318 µs/cm and 617 µs/cm correspondings to mineralization between moderately accentuated and accentuated. The wastewater from all these laundries has dissolved solids (T.D.S) values varying between 170 mg/L and 334 mg/L. This water is therefore considered to be of excellent quality, not posing a problem for the receiving environments into which it is discharged.

**Hydrocarbons (HC):** Table 4 shows the hydrocarbon contents of the discharge water from the laundry facilities in the Borough of Douala 4<sup>th</sup> above the authorized limit for the discharge of this type of effluent in the receiving environment. These values vary between 10.52mg/L and 68.20mg/L. Three out of five laundries have water with a hydrocarbon content between three and more than six times higher than the standard. Such water requires treatment before it is released into nature. It will therefore be a question of regularly monitoring the concentration of this pollutant in these waters.

**Copper (Cu):** Liquid discharges from laundry facilities in the Borough of Douala 4<sup>th</sup> have copper contents well above the acceptable standard for the discharge of this type of effluent in the natural environment. These values, between 3.28mg/L and 7.24mg/L, are three to seven times greater than the authorized limit (1mg/L). Copper must, like hydrocarbons, be controlled before any effluent discharge into the natural environment. It will be a question of setting up a treatment method to eliminate as much as possible this pollutant in the water discharged into nature.

**Iron (Fe):** The results of Table 4 show the iron contents much lower than the authorized limit (5 mg/L) for industrial effluent discharges in the natural environment. Such values have no impact on the environment where this wastewater is discharged.

**Nickel (Ni):** The nickel content of the wastewater from the Douala 4<sup>th</sup> laundry facilities is below the admissible limit for industrial discharges into the natural environment. This pollutant could have harmful effects on the environment and the health of populations only in the long term because of its bioaccumulative nature.

**Cadmium (Cd):** Almost all of the samples have cadmium contents below the authorized limit (1mg/L) for discharges of liquid effluents into the natural environment. Only one laundromat is an exception: this is the laundromat opposite the MAYOR BONABERI company, whose wastewater has a cadmium content of 2.10 mg/L, twice as high as the standard. This discharge point will have to undergo treatment with regular checks for this pollutant before the water from this laundry is discharged into the natural environment. In the rest of the cases, the negative effects of cadmium on the environment and the health of the populations of this locality could only be noted in the long term because of its bioaccumulative nature.



### 3-5- Physico-chemical analysis of wastewater from laundry facilities in the 5<sup>th</sup> district of Douala

Table no. 5 groups together the various physicochemical parameters measured in the water of the laundries in the 5<sup>th</sup> district of Douala.

**Table No. 5:** Different physicochemical parameters measured in the water of laundry facilities in the district of Douala 5<sup>th</sup>

Parameters Analyzed location of the Laundromat or collection point in Douala 3 <sup>rd</sup>	Borough of Douala 5 <sup>th</sup>								
	pH	T°C	Conductivity µs/cm	T.D.S mg/l	HC ppm	Copper Cu ppm	Iron (Fe) ppm	Nickel (Ni) ppm	Cadmium (Cd) ppm
Hôpital général Behind the groupe scolaire –Monde Uni	7,2	28,1	542	291	66,9	1,86	6,27	1,3	1,85
Axe lourd Bepanda à côté du célèbre Bar)	6,48	28,1	286	154	28,5	8,59	11,80	2,21	0,75
Carrefour Ma'ala- bepandaCamtel	6,84	28,1	247	130	9,41	7,75	8,70	1,91	0,67
Entrée bepanda 2eme avenue	6,72	28,1	303	162	40,1	9,21	3,57	1,03	0,21
Makepe-orange	6,89	28,2	421	217	88,2	4,4	0,68	3,4	0,42
Carrefour cite des palmiers	6,88	28,2	359	194	57,1	11,50	2,29	4,14	1,47
Carrefour le dollar vers hôpital général	6,83	28,2	204	104	6,55	1,47	1,30	0,06	1,66
Face SGBC Bonamoussadi	6,82	28,2	387	206	79,3	3,07	0,53	0,07	2,87
Face station serviceTradexBonamoussadi	7,15	28,3	426	229	33,1	2,49	0,28	0,03	2,95
LAVERIE APRES LE JC	6,6	28,2	190	102	22,2	2,05	0,74	0,02	3,08
Log Mpom avant le carrefour Williams Andem	6,46	28,3	211	114	46,5	1,72	5,50	3,65	4,07
Carrefour Pendaison	6,73	28,4	286	146	8,1	1,02	0,65	0,84	4,33
PK 14 face station Gulfyn	6,84	28,3	414	220	65,7	1,3	3,55	1,70	2,37
Ndog bong face commissariat 10 <sup>er</sup>	6,08	28,4	286	146	8,1	1,02	0,65	0,84	4,33

The pH values of the discharge water from the laundry facilities in the Arrondissement of Douala 5th vary between 6.08 and 7.20. We can say that these waters are slightly acidic. However, their acidity has no impact on the environment in which they are discharged because these values remain within the range of pH accepted for discharges of industrial effluents in the natural environment. The temperature of the wastewater from the laundries in the 5th district of Douala is constant at 28°C. This value remains below the limit allowed for industrial wastewater in the natural environment. Such releases have no adverse effects in the receiving environments where they are released from a temperature point of view. The conductivity of liquid effluents from laundry facilities in the 5th district of Douala varies between 190  $\mu\text{s} / \text{cm}$  and 542  $\mu\text{s} / \text{cm}$ . This indicates that the mineralization of these waters is between the low and accentuated levels. The limit allowed being 200  $\mu\text{s}/\text{cm}$ , there is only one laundromat whose conductivity is lower than this limit. From the point of view of mineralization, we can say that these waters are conductive even if this conductivity may be below. The total dissolved solid of these liquid discharges are much lower than the acceptable limit according to the discharge standards of the thirteen (13) countries: 1000 <TDS <2000 mg/L (Australia, Belgium, Denmark, France, Great Britain, Holland, Hungary, Italy, Poland, Switzerland, Canada, India, Egypt). These releases do not harm the environments where they are released for this parameter.

**Hydrocarbons (HC):** The laundry facilities in the 5th district of Douala have their discharge water loaded with hydrocarbons since the results of Table 5 show that the fourteen laundry facilities whose discharge water was analyzed have hydrocarbon contents higher than the authorized limit (5 mg/L) for industrial effluents in a natural environment [14]. It is in this locality of Douala that we note the highest levels of wastewater in this pollutant. These are the discharge points of the Face SGBC Bonamoussadi (79.3 mg/L) and MAKEPE orange (88.2 mg/L) laundry facilities. This pollutant must therefore be subject to regular monitoring during any treatment operations for this water before it is released into the natural environment.

**Copper (Cu):** The discharge water from all the laundry facilities in the 5th district of Douala has copper contents above the authorized limit, which is 1 mg/L. These values vary from 1.02mg/L to 11.50mg/L. almost half of this discharge water (six out of fourteen) has concentrations three to eleven and a half times greater than the permitted limit. Because of the foregoing, it should be said that the receiving environments into which the wastewater from the laundries is discharged

are exposed to copper metal pollution. The populations of this locality engaged in different activities need water for them and even land for their crops. The receiving environments containing this pollutant, and because of its bioaccumulative nature, would be exposed to the possible harmful effects of the metal copper. This pollutant must therefore be subject to regular monitoring during the wastewater treatment operations of the laundry facilities in this locality in the city of Douala.

**Iron (Fe):** The results in Table 5 indicate the iron content of the discharge water from the laundry facilities in the 5<sup>th</sup> district of Douala below the admissible limit. The wastewater from a single laundry (BEPANDA heavy axis next to the famous Bar) has a concentration (11.80 mg/L) slightly above the authorized limit. We can therefore say that this element does not present a risk for the environment and the populations of this town of Douala 5<sup>th</sup>.

**Nickel (Ni):** Wastewater from laundry facilities in the 5<sup>th</sup> district of Douala has nickel-metal contents that vary between 0.02mg/L and 4.14mg/L. Eight of the fourteen samples analyzed have levels of this pollutant above the authorized limit (1 mg/L) for this type of discharge into the natural environment. Four laundries have wastewater that has levels two to four times higher than the limit. Populations could be exposed to the harmful effects of the metal nickel. This pollutant must therefore be checked regularly during the wastewater treatment operations of the laundry facilities in this part of the city.

**Cadmium (Cd):** Table 5 shows that ten of the fourteen samples analyzed have cadmium contents above the authorized limit (1 mg/L) for industrial discharges in the receiving environment. Half of the laundromats have wastewater whose contents are two to four times higher than the limit. Because of the findings, the environment of the 5<sup>th</sup> district of Douala could be adversely affected by discharges from laundry facilities due to cadmium metal due to the bioaccumulative nature. The content of the wastewater in this metal must therefore be subject to regular control.

### **3-6- Average content of the Physico-chemical Parameters by District**

Table no. 6 groups together the average contents of the physicochemical parameters by district.

**Table no. 6:** Average of the concentration of parameters by District.

Parameters	Average concentration per district				
	Douala 1 <sup>st</sup>	Douala 2 <sup>nd</sup>	Douala 3 <sup>rd</sup>	Douala 4 <sup>th</sup>	Douala 5 <sup>th</sup>
<b>pH</b>	6,53	7,05	6,90	6,67	6,76
<b>T°C</b>	28,2	28,8	28,09	28,1	28,23
<b>EC µS/Cm</b>	434,5	578,25	299,19	423,6	325,58
<b>TDS (mg/L)</b>	232	305,13	239,07	228,4	172,5
<b>HC (mg/L)</b>	19,07	44,53	31,89	32,79	39,99
<b>Cu (mg/L)</b>	5,86	7,00	3,83	5,72	4,11
<b>Fe (mg/L)</b>	0,60	5,27	2,10	1,20	3,33
<b>Ni (mg/L)</b>	0,48	1,84	1,23	0,44	1,52
<b>Cd (mg/L)</b>	1,83	4,61	2,51	0,83	2,22

The pH of the wastewater from laundry facilities in the city of Douala varies on average, between 6.53 and 7.05. From these values, we can say that we have the pH of practically neutral media with a tendency towards slightly acidic media. This type of discharge does not pose any problem from the point of view of the pH in the receiving environments where it is discharged. The average temperature in the discharge water from laundry facilities in the five districts remains almost constant at around 28 °C. Such a temperature of the discharges does not influence the environments where they are discharged and therefore no problem for the receiving environments of the city of Douala. The average conductivity varies between 299.19 µS/Cm and 578.25 µS/Cm corresponding to moderately accentuated to accentuated mineralization levels. However, for industrial wastewater in a natural environment, the limit standard for the conductivity content is 200 µS/Cm. Also, it should be noted that the more the conductivity increases, the more the mineralization is important, and the more the solution is an electric current conductor [27]. The mineralization of all the discharge water from the laundry facilities in the city of Douala must be checked before any discharge into the receiving environments of this city. The average TDS in the discharge water from laundry facilities in the city of Douala varies between 172.5 mg/L and 305.13 mg/L. These values remain well below the limit recommended by the standards of thirteen countries at 1000 <TDS <2000 mg/L. The solids

dissolved in the liquid effluents of the Douala laundries do not pose a problem for the receiving environments which receive them.

**Hydrocarbons (HC):** The average concentrations of hydrocarbons in the laundry facilities in the city of Douala vary from 19.07 mg/L to 44.53 mg/L. values much higher than the authorized limit (5mg/L) for discharges of industrial liquid effluents in the natural environment. These values are almost four to nine times the limit. The presence of high concentrations of hydrocarbons on the surface of an aquatic environment can, through entanglement, cause a loss of thermal insulation and buoyancy in mammals and birds, as well as affect plankton, algae, and fauna. microscopic (Jauzein et al., 1995) [15]. The wastewater from these laundries must be treated to rid them of this pollutant before it is discharged into receiving environments.

**Copper (Cu):** The average copper concentration in the wastewater of the city of Douala varies between 3.83 mg/L and 7.00 mg/L. These values are almost four to seven times higher than the allowable discharge limit. These waters, which mostly cross the ground before reaching rivers or lowlands, go by infiltration, reach the water table and especially that several sectors of the lower part of the city suffer from the rise of the water table nearby groundwater, in particular the grounds of the airport and the New-Bell, Nylon, and Madagascar districts [19].

**Iron (Fe):** The iron contents of the discharge water from laundry facilities in the city of Douala vary from one arrondissement to another. However, these values remain below the authorized discharge limit (10mg/L). This element, although important in the body, has harmful effects on health at very high doses; a reason why the WHO recommends not to exceed the iron intake in the body to 300mg/L, because it is not good for the digestive system (O.-P.-S., 198 7) [20]. A possible carcinogenic effect in association with benzo [a] pyrene (B [a] P), ferrous oxide particles being considered as cofactors [21-24]. Iron very often plays an important role in the transfer of the metal arsenic in the waters of the subsoil [26]. The oxidation of iron in aquatic environments [26] has harmful effects on its environment. This is the case with aquatic flora, which is covered with a layer of orange rust with a reddish-brown tendency that can be very dark [25], preventing any other exchange between plants and their living environment.

**Nickel (Ni):** We note that three of the five districts studied have average nickel contents above the accepted limit (1 mg/L). These values vary between 0.44mg/L and 1.84mg/L. Note also that

the three districts which have average nickel contents higher than the standard have 75.3% of the population of the city of Douala (INS / BUCREP2005). Also, this metallic trace element being bioaccumulative, it is necessary to be wary of it because even at low doses, it may cause adverse effects on health and the environment. It should also be the subject of special monitoring during wastewater treatment operations from these laundries.

**Cadmium (Cd):** The average cadmium levels are above the authorized limit in almost all of the districts studied in the city of Douala. Only Douala 4th has a lower average cadmium content (0.83 mg/L) in the discharge water from the laundry facilities. In the other districts, these averages vary between 1.83mg / L and 4.61mg/L. Cadmium is a heavy metal that has a bioaccumulative character. It has harmful effects on the organisms of the ecosystems of the receiving environments. It is therefore very possible that the presence of this element in the discharge water of the laundry facilities in the city of Douala harms the biological and animal diversity of the receiving environments which are in particular the rivers, the soil, and the water table close to the surface.

## CONCLUSION:

The objective of this work was to assess the effluents from the laundry facilities in the city of Douala, then to carry out a physicochemical characterization by determining certain major and global parameters of the pollution of this wastewater and to identify the related risks to human health. It emerges from the results obtained that the wastewater from car laundries in the city of Douala as a whole has a practically neutral pH, close to acidic environments. The average temperature is 28.28 ° C and remains below the limit authorized for this type of discharge into natural environments. The average conductivity obtained is 412.22 µS/Cm. The average iron content ([0.6-5.3 mg/L]) is well below the authorized limit. Hydrocarbons, metals copper, nickel, and cadmium have levels above the WHO standard and could constitute a danger to human health and the environment. The wastewater from car laundries in the city of Douala is much more loaded with copper polluting followed by Cadmium and finally Nickel. It would be interesting to consider treating this wastewater from laundry facilities in the city of Douala before it is released into the environment.

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