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Soil and Water Pollution by Mercury from Waste Electrical and Electronic Equipment

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Abstract

At the end of their life, waste electrical and electronic equipment, WEEE or D3E for short, presages a problem on the environment. In fact, WEEE contains heavy metals or trace metal elements including mercury. However, if mercury is poorly managed in many African cities, it is dangerous for the environment and health. Two theories were chosen for this study: the theory of the stain of Marie Douglas and the theory of the habitus of Pierre Bourdieu. To compare results, samples of soil and water contaminated in gutters were taken from the front of repair shops in some areas of the city of N'Djamena in Chad; control samples outside the workshops. The results of the analyses obtained show that, unlike the control sites, the soils and waters of the sites studied at the shop fronts are contaminated because of their mercury content (10 to 11 µg/l for soils and 1.1 to 2.2 µg/l for waters) is much higher than normal (1 µg/l) for soils and slightly higher for waters. As the current mode of management of WEEE in some African cities is informal and exposes the environment to an obvious risk of pollution, this work will allow stakeholders to better reflect on an appropriate management solution.

Keywords

Waste, Electrical and Electronic Equipment, Environment, Mercury, Soil, Water, Pollution

1. Introduction

For more than ten (10) years, the populations of Chad in general and those of N'Djamena in particular have started to acquire important electronic and electrical equipment including mobile phones, computers, refrigerators, fans, televisions, toys etc., new or second hand. Electrical and Electronic Equipment are tools that have affected almost all sectors of activity. These electrical and electronic devices are proliferating throughout the city. At the same time, Africa in general has become a dumping ground for locally produced or imported WEEE The quantity of new and second-hand electrical and electronic equipment imported into Chad from various countries in Africa and the rest of the world between 2012 and 2021 is broken down as follows: China leads the way (118049263.6 tonnes) followed by the USA (90729541.98 tonnes) and Hong Kong SAR (31016014 tonnes). In Africa, Tunisia (9998296 tonnes), Nigeria (2720720 tonnes) and Cameroon (1557753 tonnes). In addition to these data, there are those concerning the evolution of imports over ten (10) years, which show that imports increased from 2012 to 2015. From 2016 onwards, they feel due to the economic crisis that Chad experienced in connection with the fall in oil prices on the international markets. They picked up again from 2017 to 2018 before probably falling back with the COVID 19 crisis and picking up again from 2020. In Africa, the use of Electrical and Electronic Equipment is still low compared to other countries in the world, but it is experiencing a vertiginous growth. According to data from the World Bank 2010, and ITU 2008 for the last decade, the penetration rate of personal computers has increased tenfold while the number of mobile phones has increased hundredfold [1]. While electrical and electronic equipment is popular with purchasers for its affordable prices and services, at the end of its life cycle it is a real waste that is difficult to manage (Diagnostic technical study report on the management of waste electrical and electronic equipment in Côte d'Ivoire) [2]. Thus, at the end of their life, they are called Waste Electrical and Electronic Equipment (WEEE or D3E). This waste contains both toxic components (lead, mercury, cadmium, etc.) and valuable materials such as plastic, base metals such as steel, aluminum or copper and precious metals such as gold, silver or palladium [3]. An article by the "Foundation of the territories of tomorrow" entitled "Risk of electronic waste for sustainable development in Africa", notes that the flow of electronic and electrical waste in Africa is considerable and that this waste is a threat to people and the environment [4].

This used disposable waste is made up of harmful elements that can be dangerous to health and the environment, as they contain many heavy metals. When they find their way into the food chain, following their dispersion in nature, heavy metals can be highly toxic for humans, animals and the environment [5]. According to Médiaterre "Global Francophone Information System for Sustainable Development (2012)", West Africa is currently faced with a growing flow of Waste Electrical and Electronic Equipment (WEEE), not only from domestic consumption but also from industrialized countries. According to the same source, in a new report, the UN has expressed alarm at the consequences for the environment and for people, and has called for urgent sustainable management of this waste [6]. In a 2012 report, the UN explains how West Africa has to cope with a growing flow of waste from domestic consumption of new and used electrical and electronic equipment. In the five (5) countries examined in this report (Benin, Côte d'Ivoire, Ghana, Liberia and Nigeria), between 650,000 and 1,000,000 tonnes of e-waste from domestic consumption are produced each year [7]. The United Kingdom is the main exporter of new and used EEE to Africa, followed by France and Germany with large differences. Nigeria is the main African importer of new and used EEE, followed by Ghana [8]. Electrical and Electronic Equipment are an integral part of everyday life. It is in this sense that Vanessa Forti *et al.* (2020, p.9) inform that the Electrical and Electronic Equipment (EEE) occupies a preponderant place in our daily life [9]. Their availability and widespread use enable a large part of the world's population to enjoy better living conditions. However, our production, consumption and disposal of WEEE are not sustainable. Depending on the nature of their constituents and their properties, certain wastes represent a specific hazard to humans or the environment and are considered hazardous. These include, for example, waste containing heavy metals (lead, cadmium, mercury, arsenic…), hydrocarbons, explosive, oxidizing or flammable wastes, irritant wastes, etc. [10].

2. Materials and Methods

The method used is spectrophotometry. It involved taking a soil sample, dissolving it in distilled water, adding mercury reagents and placing this solution on the colorimeter, which gives the result directly in mg/l.

2.1. Spatial Delineation of the Study

This study is carried out in Chad; a central African country located between the 8th and 23rd degrees of latitude north and between the 14th and 24th degrees of longitude east. The country has embarked in recent years on major investments to build or rehabilitate infrastructure and equipment for a general take-off of the national economy and ensure better living conditions for the population [11]. The city of N'Djamena, capital of Chad and site of this study, is located between 11˚ and 12˚8 latitude North and 14˚2 and 15˚2 longitude East. It is supported by a flat alluvial plain whose altitudes vary between 293 and 298 meters. N'Djamena is the country's most populous city 1456710 inhabitants in 2018 according to the World Bank (WB) projection cited by Abdelmadjit Ali Ahmat (2018) and the country's capital [12]. Relatively better living conditions mean that it is likely to produce the most electrical and electronic equipment waste. These are the reasons for his choice for this study. **Figure 1** locates geographically the city of N'Djamena as well as the neighborhoods that are the subject of this study.

In **Figure 1**, the eleven (11) districts that are the subject of this study are presented. These are the Neighborhoods Hilé Houdjadj, Madjorio, Klémat, Naga II, Ndjari, Dembé, Moursal, Chagoua, Ridina, walia and Kabalaye. They are representative of all the boroughs in the city of N'Djamena. However, six (6) of these districts are concerned with soil and water sampling.

2.2. Theoretical Framework

Waste is now a major environmental problem for humanity because the more it is produced; the more difficult it is to dispose of. According to Naskida (2018, p. 91), it is clear that waste is a source of environmental pollution [13]. Because the direct discharge of solid and liquid household waste contains harmful particles that pollute the soil, water in the city of N'Djamena in Chad.

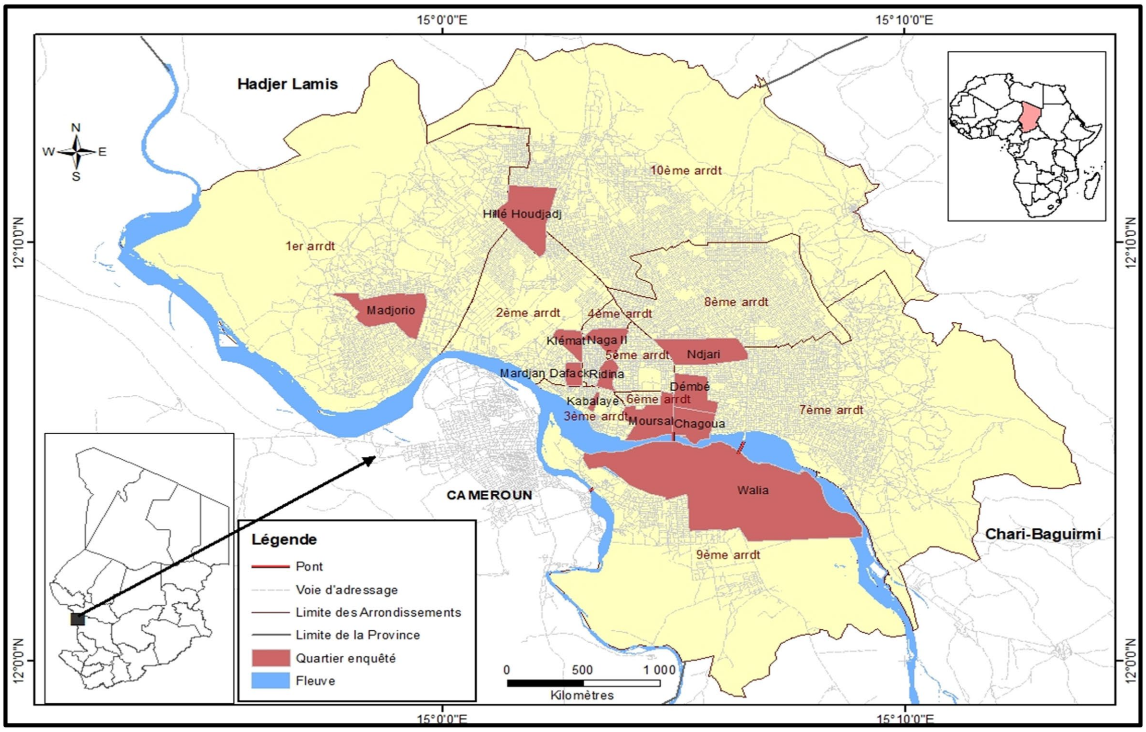

Figure 1. Study Neighborhoods (Source: Field data.2022. Projection: WGS 84).

2.3. Mary Douglas' Theories of Soiling (1967)

The theories of "soiling" of Douglas are logically retained for this study related to waste management in general and that of electrical and electronic equipment in particular. Throwing away waste anywhere can only be a mess, coexisting with dirt has always been discouraged [14]. Mary Douglas, in her 1967 essay entitled "Essay on the concepts of pollution and taboo", argues that every culture must deal with the anomalies arising from its system. It then introduces the notion of boundary soiling to understand how primitive societies rationally select dangers. This exciting book is also the prelude to an anthropology of risk that Douglas will later develop in a political-legal theory of danger in the West. M. Douglas (1967) shows that there are no fundamental differences between the religions of faith and primitive magic. In both cases, the management of impurity is based on a certain symbolic organization of the concrete world, whose construction is more intellectual than moral or spiritual (Picardie Jules Verne *et al.*, Amiens, 2019). Naskida (2018, p. 83), notes that Douglas's theories on the conceptualization of "soiling", "dirt" and "waste" as markers of the internal and external boundaries of a social and symbolic system, and thus indicative of a certain conception of "order", have continued to feed the reflections of social science researchers, both anglophones and francophones, on the themes of soiling and purity in religion, maintenance of living spaces and bodies, pollution, and of course waste management.

2.4. The Theory of the Habitus by Pierre Bourdieu (1972)

Environmental education is becoming an imperative for changing the behavior of urban populations, especially in Africa, which is being plagued by a rural exodus with a mentality that is very little focused on the culture of household waste management and personal awareness on the phenomenon. This is why the theory of practice based on the concepts of "structuralist constructivism" by Pierre Bourdieu is finally included in this work. Thus, the key concepts used by Pierre Bourdieu are as follows: Habitus-Fields-Capital [15].

By definition, according to Pierre Bourdieu, the Habitus is a system of acquired dispositions, incorporated in a lasting way, and tending to reproduce the logic of the conditionings that are at its origin. Therefore, the habitus explains how norms and values are acquired, incorporated and tend to reproduce. The habitus allows the individual to integrate into his group, to shape his vision of the world and to get an idea of his place within his group. These provisions (norms, values, etc.) will be historically externalized and crystallized, in turn, at the field level: spaces of social life that become relatively autonomous around their own relationships, resources and issues.

In N'Djamena, the current management of WEEE and therefore mercury is one of the worst in Africa and can only impact the soil and water from where the choice of the subject of the article. Spatial sampling took into account neighborhoods with similar characteristics, such as the quality of housing, roads, equipment, activities and forms of habitat or garbage collection services. The workshops in the neighborhoods were systematically identified before some were randomly selected for soil analysis and others retained due to the presence of gutters in front of the workshops.

Table 1. Distribution of Neighborhoods selected for study (Source: 2021 field survey).

No.	Type of Neighbourhoods	Neighbourhoods
1	Residential	Klémat
2	Traditional old	Kabalaye Ridina
3	Traditional intermediate	Naga II Moursal
4	Traditional recent	Walia Hilé Houdjadj Chagoua Djari Madjiorio Dembé

These districts (Table 1), represent the characteristics of all the districts of N'Djamena. The Chagoua, Dembé, Walia, Hilé houdjadji, Naga II, Kabalaye and Ridina districts were sampled from soil and water.

Since there are several types of electrical and electronic equipment, Directive 2002/96/EC of the European Parliament and of the Council (2003) has divided them into ten (10) categories:

1) Large household appliances: refrigerators, freezers, air conditioners, oven etc.;

2) Small household appliances: micro, wave, water heater, coffee maker etc.;

3) Computer Equipment : computer, printer, photocopier etc. ;

4) Consumer Equipment: electric razor, mobile phone, hair dryer, video player, iron, fan etc.;

5) Lighting Equipment: tubes and discharge lamps (fluorescent tube, sodium bulb, low consumption/economic bulb;

6) Power and electronic tools (except large stationary industrial tools): drill;

7) Toys, leisure and sports equipment;

8) Medical devices (except for all implanted and infected products);

9) Monitoring and control instruments;

10) Vending machines.

Field observation, given the large number of electrical and electronic equipment, it is difficult to study all categories and types of WEEE that exist, so after field observation, this study focuses on three (3) categories of equipment deemed most used and visible in N'Djamena (Table 2). It should be added that a category of these wastes named in this study, mixed wastes would be added to this list because they are composed of the same wastes but already dismantled.

Table 2. EEE breakdown by category (Source: WEEE-Cote d'Ivoire 2011 Management Study).

No.	Category	Equipment	Characteristics
1	Large electric Appliance	Refrigerator	Single-Blades medium refrigerator
		Freezers	Vertical medium freezers
		Refrigerator and freezers	Double-walled refrigerators and freezers
2	Computer and electronic Equipment	Laptops	Medium laptops, 14 - 15-inch screen
		Printers	Medium laser printers
		Photocopier	Average copier
3	Consumer Equipment	Televisions	Television sets Witz CRT
		Hi-Fi radio	Medium Hi-Fi Channels
		Fans	Medium end fans
		Mobile phones	Ordinary mobile phones

Table 2 presents the three (3) categories of Electrical and Electronic Equipment are actually retained.

To determine the mercury content in soil and water, the sites shown in Figure 2 were sampled.

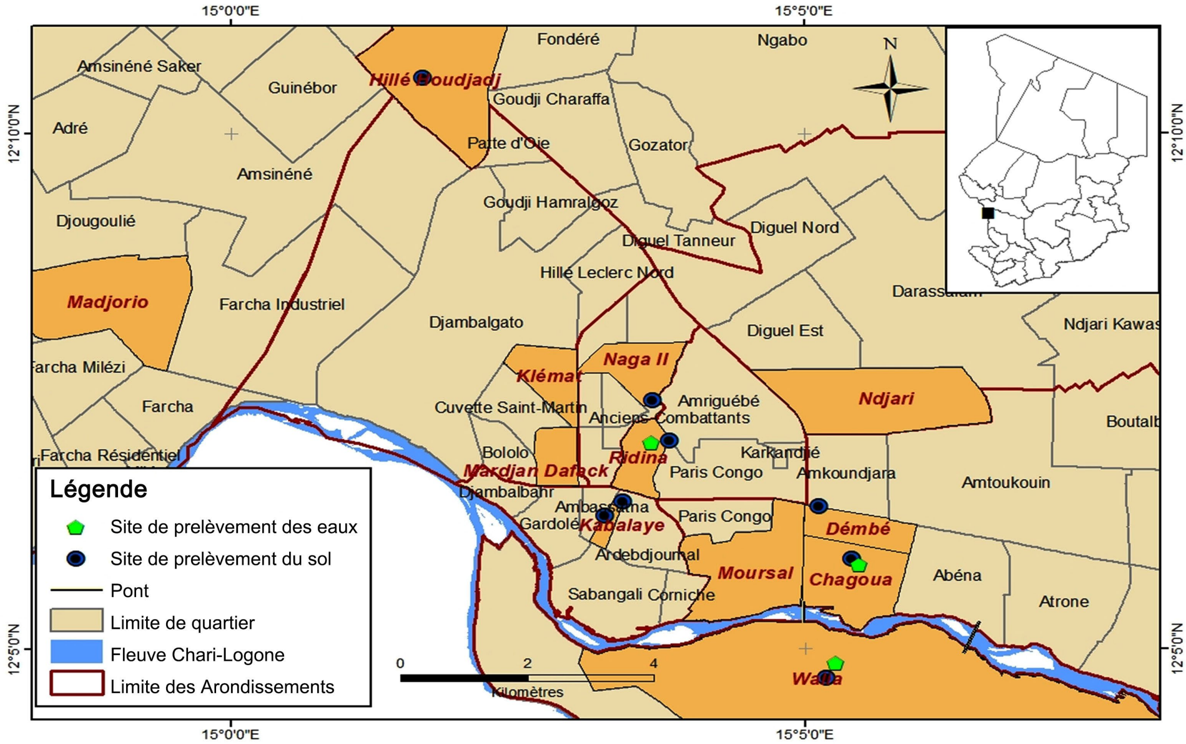

Figure 2. Soil and water sampling site (Source: Field data. 2022. Projection: WGS 84).

Soil samples were taken at the shop fronts in (6) six of our randomized study Neighborhoods. For water sampling, these are samples taken at the front of two (2) workshops of two (2) Neighborhoods but chosen because at the front of these workshops there are gutters from which the water to be analyzed could be taken. The test soil and test water were taken outside of the workshops but in a district covered by this study.

For this work, GARMIN GPS is used to record the geographic coordinates of repair shops and sampling sites. The GPS points have therefore been spatialized thanks to the GIS software for the production of maps. GIS Arc GIS Software Version 10.6.1 was used for the mapping work.

For soil and water sample collections, the following materials have identified mercury in these samples. For soil and water sampling: Gangs, nose masks, plastic bags to store soil samples; a cooler to store samples; two motorcycles for travel; a spatula that allows the sampling of soils; 250 ml sample bottles for water samples; a marker for ratings; a GPS for the coordinates of the sampling points; 250 ml tube for the sampling of drainage water and a beaker to weigh the soil sample. The sample is taken here at the front of a repair shop at 8 o'clock. Using a spatula, the surface part of the soil is taken for analysis in order to detect ETM dispersed at the shop front. The same sampling procedure was used for water. Using a tube, the sample of the sewer water at the front of this repair shop is collected. In the background of the photo, the carcasses of televisions crammed for years by the repairer. Once the data is obtained, it is necessary to move on to the next even more crucial step, which is data processing and analysis.

3. Results and Discussion

Mercury is a naturally occurring metal that also propagates through so-called natural phenomena. Today, with the digital revolution, the use of mercury is becoming increasingly important, especially through human activities with the multiplication of electrical and electronic equipment of all kinds. It can be found in mines, industries and WEEE landfills. For this study, the question arises in terms of the impact of mercury on soil and water.

This study shows in this part that the soils and waters of some districts have a higher content of Trace Metal elements than WHO standards and already affected while others have a lower content than the standards and therefore not affected. The WHO international regulations set the limit for the content of each heavy metal. For mercury, regulations currently set limits at 1 μg/l.

3.1. Very High Mercury Content in Most Soil-Polluting Sites

Mercury is emitted from natural sources but also by anthropogenic activities through, among others, electricity production, other energy sectors, waste treatment, urban heating, and the poor management of WEEE etc. It is a global pollutant found everywhere and therefore in soils as well. **Table 3**, for example, provides the percentage of mercury content in each studied area.

Table 3. Percentage of mercury in soil by studied district (Source: 2022 field survey).

No	Neighbourhoods	Content	Percentage
1	Chagoua	4	11.97
2	Dembé	11	32.93
3	Hilé Houdjadj	0.6	1.79
4	Naga II	2.4	7.18
5	Ridina	10	29.94
6	Kabalaye 1	2.6	7.78
7	Kabalaye 2	2	5.98
8	Control soi	0.8	2.39
Total		33.4	100

The percentages in this **Table 3** show the predominance of the Dembé district (32.93%) closely followed by the Ridina district (29.94%). Kabalaye 1 and Naga II have 7.78% and 7.18% each. The others are Kabalaye 2 (5.98%), Ridina (5.35%). The control soil and the site of Hilé Houdjadj each have 2.39% and 1.79%. For this study, **Figure 3** shows first the content at the different sites studied and then the comparison with international standards.

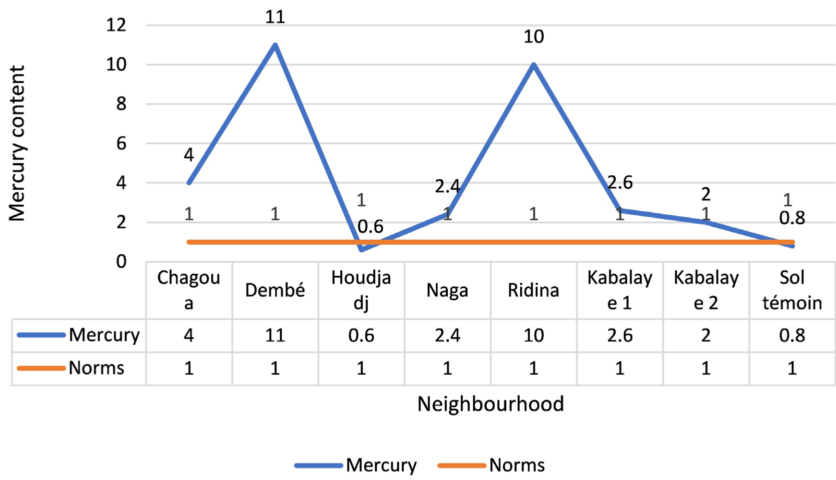

Figure 3. Comparison of mercury content at the sites studied with WHO standards.

Table 4. Mean mercury levels in soils at the sites studied (Source: 2022 laboratory analysis).

No.	Soil	Mercury (µg/l)
1	Chagoua	4.00
2	Dembé	11
3	Houdjadj	0.6
4	Naga II	2.4
5	Ridina	10
6	Kabalaye 1	2.6
7	Kabalaye 2	2
8	Control soil	0.8
	Average	4.17
	Norms OMS	1

Table 4 shows the figures for mercury levels in the different areas studied that are above international standards (Norms OMS). The average mercury is above the norm here.

3.2. Higher Mercury Content in Water at Sites Studied

Like other MTTs, excessive mercury in water can be a source of contamination of water and hence living things. The percentage of mercury in water in each district is shown in Table 5.

Table 5. Percentage of mercury in water at sites studied (Source: 2022 field survey).

No.	Sites	Content	Percentage
1	Chagoua	2.2	53.65
2	Ridina	1.1	26.82
3	Control water	0.8	19.51
Total		4.1	100

In Table 5, the largest percentage is that of Chagoua with 53.65. Then comes the Ridina with 26.82 and water control, which has 19.51.

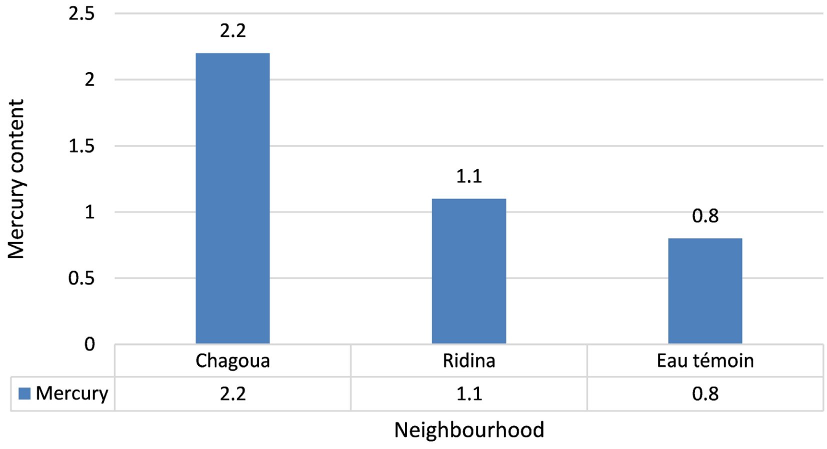

Figure 4. Mercury content in water at sites studied, in µg/l.

In Figure 4, mercury is higher at Chagoua with 2.2 than at Ridina 1.1 or in the 0.8 control water. However, both Chagoua and Ridina are above the norm.

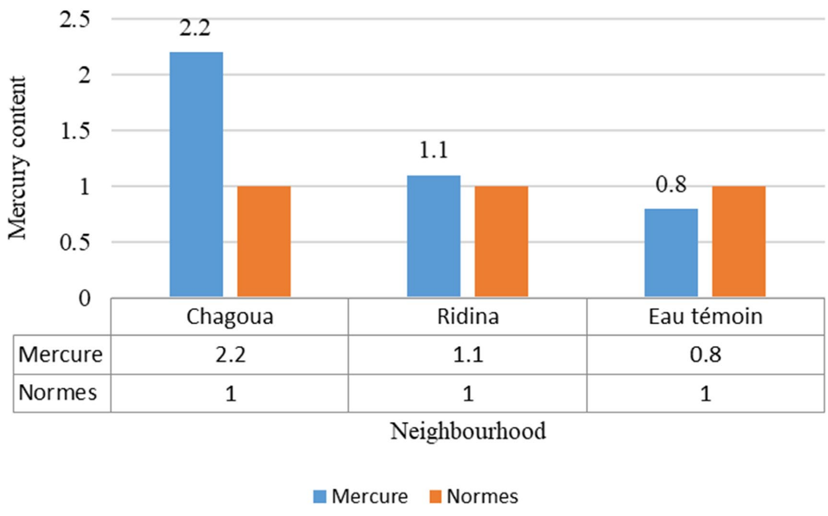

Figure 5. Comparison of mercury content at sites studied and standards.

The mercury content at Chagoua (2, 2) on Figure 5 is well above the standard of one. The water sample here is taken in front of a TV repair shop. Also, in the Ridina neighborhood, water is taken from a TV, stabilizer and radio repair shop and the content is slightly above standard (1, 1). Only the control water is below standard (0.8).

The average mercury in soil and water at repair shop fronts in N'Djamena is above standard. Mercury could contaminate all the soils of N'Djamena. Mbadbral

(2018, p. 68) argues that soil pollution in N'Djamena is also linked to areas previously filled with rubbish and depressions where litter has accumulated. The same author concludes that harmful particles from waste pollute soil and water and have adverse effects on public health (p. 304). Soil and water sampling at the front of repair shops as well as control sampling also help to remove any doubt about the impact of copper from WEEE on soil and water. According to J.F. Thomassin and S. Touze (2003, p. 4), the behavior of mercury in air, soil and water is influenced by anthropogenic inputs. It turns out that mercury should circulate freely for years without having impacts except on soil and water. This is the view of Ian Marnane, an expert from the European Environment Agency (2018, p. 1), who states that Mercury is a naturally occurring element in the environment, but it is generally contained in minerals, where it does not present any significant danger. The problem is that human activities release large amounts of mercury into the environment, which can then move freely for thousands of years. The main source of concern is mercury in water and sediment, as it comes in an extremely toxic form and can be easily ingested by animals, thus making its way into the human food chain.

In Côte d'Ivoire, the usual practice of dismantling actors is to dispose of worthless parts in the lagoon or also deposit them at household waste disposal sites. These practices result in pollution of the lagoon and lead to bioaccumulation that is a real threat (WEEE Diagnostic Technical Report, 2011).

In the water samples studied, mercury was found to be higher at Chagoua (2.2 μg/l) than at Ridina (1.1 μg/l) or in the 0.8 μg/l control water. Both Chagoua and Ridina therefore have contents above the norm. This means that the water in the shop fronts is polluted and may contaminate the city environment through runoff, temperature or wind circulation. Measures to ensure proper management of WEEE ETMs, including mercury, should avoid large-scale contamination because with the technological revolution these wastes are a time bomb for the global environment. It is in this sense, for example, that Ian Marnane (2018, p. 3) believes that Europe has always been a major user and emitter of mercury. However, through significant legislative measures implemented over the past forty (40) years, mercury use and releases to the environment have decreased significantly.

Regarding the theory of contamination, in the context of this study, in N'Djamena, electronic waste can be perceived as ambiguous objects, neither totally useful, nor completely eliminated, thus "out-of-class". Their informal management (burning, artisanal dismantling) can be seen as a violation of urban and sanitary order, generating a form of "social defilement". Informal waste pickers, often marginalized, embody this tension between economic utility and symbolic rejection.

The concrete applications in the analysis of this study focus on pollution as disorder with WEEE management practices that disrupt spatial order (spontaneous discharges), ecological order (contamination of environments), and bodily order (damage to health) in the first place. Then, regarding taboos and anticivilization, waste is often relegated to the periphery, just like the populations who handle it.

This reinforces their status as "defilement" in the symbolic sense and possible rehabilitation: By integrating waste pickers into a formal sector, one can transform defilement into resource, an idea close to the circular economy.

For the habitus theory of Pierre Bourdieu, in the context of N'Djamena, it allows to analyze the informal practices of WEEE management. Waste pickers, repairers and resellers act according to dispositions acquired in an environment marked by precariousness, the absence of regulation and economic necessity. Artisanal dismantling, open burning or resale of components are socially incorporated practices, often transmitted through informal learning. Then, for the perception of environmental and health risks, exposed populations can minimize or ignore the dangers related to WEEE, not out of pure ignorance, but because their habit does not predispose them to perceive them as priorities. This partly explains the resistance to awareness policies or changes in behavior.

Finally, it should be noted that there is no reproduction of social inequalities. That is why the habits of the working classes in N'Djamena, shaped by difficult living conditions, reproduce risky practices that perpetuate negative health and environmental effects. The margins for individual maneuvers are limited by the social structures in which these habits were formed. Theoretically, habitus allows individual behaviors to be linked to social structures without falling into determinism. It offers a detailed reading of the practical logics behind behaviors that may seem irrational or dangerous. It can be crossed with the theories of Mary Douglas (contamination) and Ulrich Beck (risk society) for a multidisciplinary approach.

4. Conclusions

There is strong evidence that EMTs from WEEE are dangerous to the environment in general if they are mismanaged. Thus, the results show that the mercury content from this WEEE in the soils and waters of the sites studied are above the norm. This assumes that these soils and waters are contaminated, confirming the hypothesis. The degree of contamination varies from site to site. This is why the soils of the Dembé and Ridina districts have a higher mercury content than the Chagoua, Kabalaye or Naga II districts except for the control soil and the Hilé Houdjadj district and the control soil are below standard, therefore not contaminated. For water, the two sites studied, namely the Ridina and Chagoua sites, have mercury levels above the standard except for the control sample of water that meets the standard. In general, mercury is above standards and can contaminate all soils and waters of the city of N'Djamena. A reflection on a more efficient mode of waste management of electrical and electronic equipment is required.

This study is limited by the fact that it has only two sites in the neighborhoods studied for the case of water because the workshops in front of which the samples were taken do not have gutters through which one can sample unlike the ground. The storefront of EEE repair workshops is chosen because it is estimated that heavy metals from WEEE can easily escape, so sites located outside the repair workshops can only contain heavy metals from other sources such as paint. Thus, the difference shows that indeed soil contamination is more important at the front of repair workshops than elsewhere.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Secretariat of the Basel Convention WEEE in Africa (2012) Secretariat of the Basel Convention WEEE in Africa: State of Play.

[2] Secretariat of the WEEE Basel Convention in Africa (2011) Diagnostic Technical Study Report on Waste Management of Electrical and Electronic Equipment in Côte d'Ivoire.

[3] Dieng, D., Diop, C., El-Hadji, M.S. and Gning, J.B. (2017) Management of Electrical and Electronic Waste (WEEE) in Senegal: Actors and Strategy for the Organization of the Sector.

[4] Risk of E-Waste for Sustainable Development in Africa. https://www.googletamanager.com/ns.html

[5] Conso Globe (2009) Hazardous Waste, Batteries and Accumulators.

[6] Konseibo, S. (2012) Electronic Waste: Africa Is Choking. http://www.mediaterre.org

[7] UN Report (2012) WEEE, Where Are We in Africa?

[8] Roussel, F. (2021) Africa: 15% of WEEE Are Imported. https://m.actu.environnement.com

[9] Forti, V., *et al.* (2020) Tracking Global Waste Electrical and Electronic Equipment for 2020: Quantity, Flows and Opportunities in the Circular Economy.

[10] Kornov, L., Thrane, M., *et al.* (2007) Tools for Sustainable Development, Waste and Environmental Aspects. http://www.fostplus.be

[11] INSEED (2013) Third Survey on Consumption and the Informal Sector in Chad (ECOSIT), Final Report of June 2013. P. 143.

[12] Ali Ahmat, A. (2018) Environment and Urban Management.

[13] Mbatbral, N. (2018) Evaluation of the Impacts of Household Waste on Water, Soil and Human Health: Case of the City of N'Djamena (Chad).

[14] Douglas, M. (1967) Defilement: Try on the Notions of Pollution and Taboo.

[15] Bourdieu, P. (1972) The Theory of Habitus. Routledge.